The Influence of Emotional Body Posture on Adults' and 8-year-olds' Perception Facial Expressions

by

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Abstract

The present set of experiments was designed to investigate the development of children's sensitivity of facial expressions observed within emotional contexts. Past research investigating both adults' and children's perception of facial expressions has been limited primarily to the presentation of isolated faces. During daily social interactions, however, facial expressions are encountered within contexts conveying emotions (e.g., background scenes, body postures, gestures). Recently, research has shown that adults' perception of facial expressions is influenced by these contexts. When emotional faces are shown in incongruent contexts (e.g., when an angry face is presented in a context depicting fear) adults' accuracy decreases and their reaction times increase (e.g., Meeren et al. 2005). To examine the influence of emotional body postures on children's perception of facial expressions, in each of the experiments in the current study adults and 8-year-old children made two-alternative forced choice decisions about facial expressions presented in congruent (e.g., a face displayed sadness on a body displaying sadness) and incongruent (e.g., a face displaying fear on a body displaying sadness) contexts. Consistent with previous studies, a congruency effect (better performance on congruent than incongruent trials) was found for both adults and 8-year-olds when the emotions displayed by the face and body were similar to each other (e.g., fear and sad, Experiment 1a); the influence of context was greater for 8-year-olds than adults for these similar expressions. To further investigate why the congruency effect was larger for children than adults in Experiment 1a, Experiment 1b was conducted to examine if increased task difficulty would increase the magnitude of adults' congruency effects. Adults were presented with subtle facial and despite successfully increasing task difficulty the magnitude of the congruency effect

did not increase suggesting that the difference between children's and adults' congruency effects in Experiment 1a cannot be explained by 8-year-olds finding the task difficult. In contrast, congruency effects were not found when the expressions displayed by the face and body were dissimilar (e.g., sad and happy, see Experiment 2). The results of the current set of studies are examined with respect to the Dimensional theory and the Emotional Seed model and the developmental timeline of children's sensitivity to facial expressions.

A secondary aim of the series of studies was to examine one possible mechanism underlying congruency effects—holistic processing. To examine the influence of holistic processing, participants completed both aligned trials and misaligned trials in which the faces were detached from the body (designed to disrupt holistic processing). Based on the principles of holistic face processing we predicted that participants would benefit from misalignment of the face and body stimuli on incongruent trials but not on congruent trials. Collectively, our results provide some evidence that both adults and children may process emotional faces and bodies holistically. Consistent with the pattern of results for congruency effects, the magnitude of the effect of misalignment varied with the similarity between emotions. Future research is required to further investigate whether or not facial expressions and emotions conveyed by the body are perceived holistically.

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Adults and children engage in multiple social interactions daily. Successful navigation of social interactions often requires rapid and accurate identification of others' emotions; displays of emotion provide external evidence of others' feelings, thoughts and related intentions and behaviours (Buck, 1984; for a review see Hess & Thibault, 2009). Recognition of emotions involves attending to relevant cues (e.g., facial expressions, background scenes, body postures, and voices) present within social interactions (Buck, 1984). Research on adults' perception of emotions has been dominated by studies in which prototypical facial expressions have been presented in isolation. Based on these studies, adults are considered experts at recognizing facial expressions and can readily discriminate between prototypical expressions (Adolphs, 2002; Ekman, 1992; Ekman, 1999; Fridlund, 1991; Russell, 1980).

A wealth of studies suggests that even infants can discriminate among some emotions depicted in the human face (e.g., Barerra & Maurer, 1981; Caron et al., 1985; Nelson & de Haan, 1997; for a review see de Haan & Nelson, 1998); however, the ability to accurately recognize prototypical facial expressions continues to develop until about 10 years of age (e.g., Camras, 1980; Camras & Allison, 1985; Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). The time course over which children achieve adult-like proficiency varies across emotions, with few age-related differences for happy facial expressions and gradual improvement for other expressions (Camras & Allison, 1985; De Sonneville et al., 2002; Durand et al., 2007; Kolb, Wilson & Taylor, 1992; Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000; Widen & Russell, 2003).

Specifically, four and five-year-old children are as accurate as older children and adults at discriminating and recognizing happy facial expressions; however, they are significantly less accurate in descending order for sad, angry, fear, surprise and disgust—with the order for sad and angry sometimes reversed (Boyatzis, Chazan, & Ting, 1993; Gao, Maurer, 2009; Gosselin, 1995; Markham & Adams, 1992; for a review see Gross & Ballif, 1991; Widen & Russell, 2008b). Studies investigating the development of children's perception of facial expressions suffer the same limitation as the literature investigating adults' perception (reviewed in Aviezer, Hassin, Bentin & Thorpe, 2008a): In almost every study faces have been presented in isolation, in the absence of the contextual information that accompanies facial expressions encountered in the real world.

Within the past 5 years researchers have started to investigate the role of context in the perception of facial expressions; numerous studies provide evidence that contexts (e.g., emotional scenes, body postures, voices, hand gestures) influence adults' perceptions of facial expressions. Adults are significantly more accurate and quicker to recognize a facial expression presented in a congruent context (e.g., sad face on a sad body) than in an incongruent context (e.g., sad face on a fearful body) (Aviezer et al., 2008b; Meeren, van Heijnsbergen & de Gelder, 2005; Righart & de Gelder, 2008a; 2008b; see below for details). The magnitude of the influence of context increases as the similarity between the expressions in the face and body increases (Aviezer et al., 2008b). To the best of our knowledge no such studies have been conducted with children. Thus, in the current series of studies we examined the influence of emotional body postures on adults' and 8-year-olds' recognition of facial expressions. In the first experiment (Experiment 1) we examined the influence of body posture on the perception of two similar expressions—fear and sad. In the second experiment (Experiment 2) we examined the influence of body posture on the perception of two dissimilar expressions—happy and sad. Based on previous studies, a congruency effect was predicted in Experiment 1 but not in Experiment 2. A secondary aim of the current series of studies was to determine whether the congruency effect was attributable to holistic processing.

Theories of Emotion Recognition

The practice of presenting faces in isolation likely reflects the dominance of the Discrete Categories theory of emotion perception. Proponents of this theoretical approach assume that six basic prototypical emotions—happy, sad, anger, fear, surprise and disgust—are perceived categorically (Ekman, 1970; Izard, 1997) and that the perceiver directly detects specific emotions from the configurations of others' facial muscles. Ekman (1970) and Izard (1973) were the among the first to provide evidence that basic emotions are universal, suggesting that all humans are genetically and/or environmentally predisposed to experience and detect emotions within these basic categories (Kotsoni, de Haan & Johnson, 2001; Tomkins, 1962). Models emphasizing the perception of emotions as discrete categories are consistent with neural correlates of emotion perception (e.g., Calder et al., 1996; Gray, Young, Barker, Curtis & Gibson, 1997). Researchers suggest that there are overlapping, yet dissociable neural networks involved in the processing of specific emotions (Kesler-West et al., 2001; Streit et al., 1999). For example, the amygdala is associated with the processing of fearful and sad faces, the cingulate gyrus is associated with recognition of happy faces, the orbital frontal region is associated with the recognition of angry faces and the basal ganglia are associated with the recognition of disgust (see Batty & Taylor, 2006 for a review).

Converging evidence from studies examining emotion recognition within special populations also suggests that there are dissociable networks for the basic emotions. Gray and colleagues (1997) found that patients with Huntington's disease (associated with impaired basal ganglia function) have a highly selective impairment in the recognition of disgust. In contrast, patients with bilateral lesions in the amygdala demonstrate impaired recognition of fearful and angry facial expressions (Adolphs, Tranel, Damasio & Damasio, 1994). Thus, according to the Discrete Categories theory the basic emotions are independent of one another and facial displays reliably reflect the target's emotional state, rendering other cues to emotions irrelevant or misleading (Ekman & O'Sullivan, 1991; Nakumura, Buck & Kenny, 1990).

Although the Discrete Categories theory has been the dominant theory in the literature, several lines of research support alternative theories of emotion perception. Research using a technique called Multidimensional Scaling (MDS)—a statistical procedure that analyzes the similarities between stimuli and provides a visual representation of their similarity—has been used to examine both children's (Gao, Maurer & Nishimura, 2010) and adults' discrimination of facial expressions and/or emotional words (Bimler & Kirkland, 1997; 2001; Russell & Bullock, 1985; Schlosberg, 1952). Studies using MDS provide evidence that the basic emotional expressions are systematically related to each other with some of the basic emotions being more similar than others. Recent research provides evidence that the similarities between emotions do not reflect culturally defined categories of emotions; Susskind et al. (2007) trained computers to recognize the basic facial expressions and found a pattern of recognition errors similar to that of adult humans.

In a second line of research, investigators have examined children's errors in both discrimination and labeling tasks. Discrimination tasks do not require the participant to cognitively understand or produce emotional labels, thus they are typically used to evaluate toddlers' and younger children's perception of facial expressions (e.g., Bullock & Russell, 1984; 1985; Camras, 1980; Camras & Allison, 1985; Markham & Adams, 1992; for a review see Gross & Ballif, 1991). For example, children may be asked to select a photograph of a facial expression from a set that best matches a target facial expression or to sort photographs of facial expressions based on how similar they are to one another (e.g., Bullock & Russell, 1984; 1985; Gao & Maurer, 2009). Unlike discrimination tasks, emotional labeling tasks require participants to either choose an emotional label from a set (forced-choice paradigm) or produce an emotional label (free labeling) to best describe the facial expression presented; these tasks are used to evaluate the perception of facial expressions throughout the lifespan (Camras & Allison, 1985; De Sonneville, et al., 2002; Wiggers & van Lieshout, 1985). In both types of task, children's errors are not random; preschoolers systematically confuse negative expressions with each other but not with happy expressions (Bullock & Russell, 1984; 1985; Durand et al., 2007; Widen & Russell, 2008a; 2008b) and older children are more likely to apply negative emotion labels (e.g., sad) to other negative emotions (e.g., anger, fear, disgust) than to positive emotions (e.g., happy) (Gao & Maurer, 2009; Widen & Russell, 2002; 2003, experiments 2 and 3). Overall, the results of these studies are consistent with those of MDS and suggest that there are systematic relationships among the basic emotions.

These systematic relationships are captured by the Dimensional theory of emotion perception, which proposes that emotions can be represented by a circumplex in which prototypical emotions vary on two underlying dimensions— valence (whether the target's current emotional state is pleasant or unpleasant) and arousal (high/low) (see Figure 1).[1] Unlike proponents of the Discrete Categories theory, advocates of the Dimensional theory suggest that only arousal, valence and quasi-physical information (e.g., whether the mouth is turned up or down) can be read directly from facial displays of emotion (Carroll & Russell, 1996; Russell, 1980; Russell & Bullock, 1984; Schlosberg, 1952). Emotional categories (e.g., the basic expressions) are subsequently extracted based on these 3 pieces of information (Abelson & Sermat, 1962; Bullock & Russell, 1984, 1985; Schlosberg, 1952). For example, a face displaying low arousal and negative valence is likely to be expressing sadness whereas a face displaying high arousal and positive valence is likely to be expressing happiness. Dimensional theory explains the results of MDS studies: Emotions are likely to be judged as similar or to be mislabeled when they are matched on one or both of the underlying dimensions and thus are located in relatively close proximity to each other around the perimeter of the circumplex (for example anger and fear, see Figure 1). Dimensional theory also explains the pattern of errors observed in children: Children first perceive and understand emotions at the level of valence and so they categorize "happy" separately from all negatively-valenced emotions and only later discriminate among sadness, fear, and anger (Kolb et al., 1992; Russell & Widen, 2002; Wellman, Harris, Banerjee & Sinclair, 1995; Widen & Russell, 2008a). By 8 years, children sort prototypical expressions much like adults do (Russell & Bullock, 1985), although the underlying dimensions are not completely adult-like until later in childhood (Gao, Maurer & Nishimura, 2010). The representational structure of

[1] Arousal and valence are the most frequently studied dimensions although others have been suggested (e.g., approach/avoidance) (Scherer, 2000).

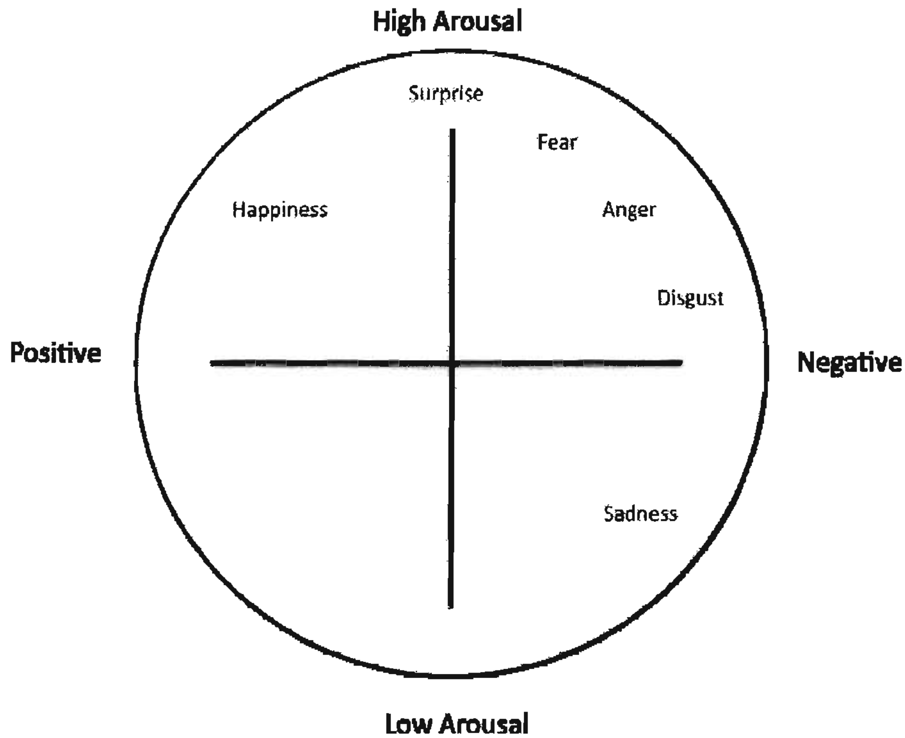

Figure 1. The cirumplex model: a schematic representation of the similarity between the prototypical *basic* emotions based on the underlying continuous dimensions of valence (horizontal) and arousal (vertical). The location of the emotions are predicted by dimensional theories of emotions (Russell & Bullock, 1985; Russell,1997)

the circumplex model for emotions has been reproduced in various cultures (Russell, 1983), with preschoolers (Russell & Bullock, 1985) and with a variety of methodologies including similarity ratings of both facial expressions (Abelson & Sermat, 1962; Cliff & Young, 1968; Russell & Bullock, 1985; Schlosberg, 1952), emotional labels (Kring, Barrett & Gard, 2003; Russell, 1980) and with ideal computer observers (Susskind, et al., 2007).

In addition to predicting that pairs of emotions will vary in similarity, Dimensional theorists also propose that the emotion conveyed by the context will influence adults' perception of emotional facial expressions. As shown in Figure 1, basic emotions located close together within a quadrant of the circumplex (e.g., fear, anger, disgust) may be inherently ambiguous because they are similar in both valence and arousal; accurate categorization may require supplementary emotional information (e.g., body posture, social context, tone of voice). When the context provides a plausible interpretation of the facial expression (e.g., when the context conveys anger and the face conveys fear) adults' judgments may be influenced by context. In contrast, when the context does not provide a plausible interpretation (e.g., when a fearful face is presented in the context of a birthday party) the influence of the context may be minimal or absent.

More recently, dimensional theorists (e.g., Russell & Carroll, 1996) and proponents of the emotional seed model (e.g., Aviezer, et al. 2008a) have proposed that congruency effects will be maximal when facial displays of the emotion conveyed by the background share physical characteristics (called emotional seeds) with the emotion displayed in the face. The relationships between the basic emotions based on physical similarity are shown in Figure 2. According to the Emotional Seed model, any given facial expression

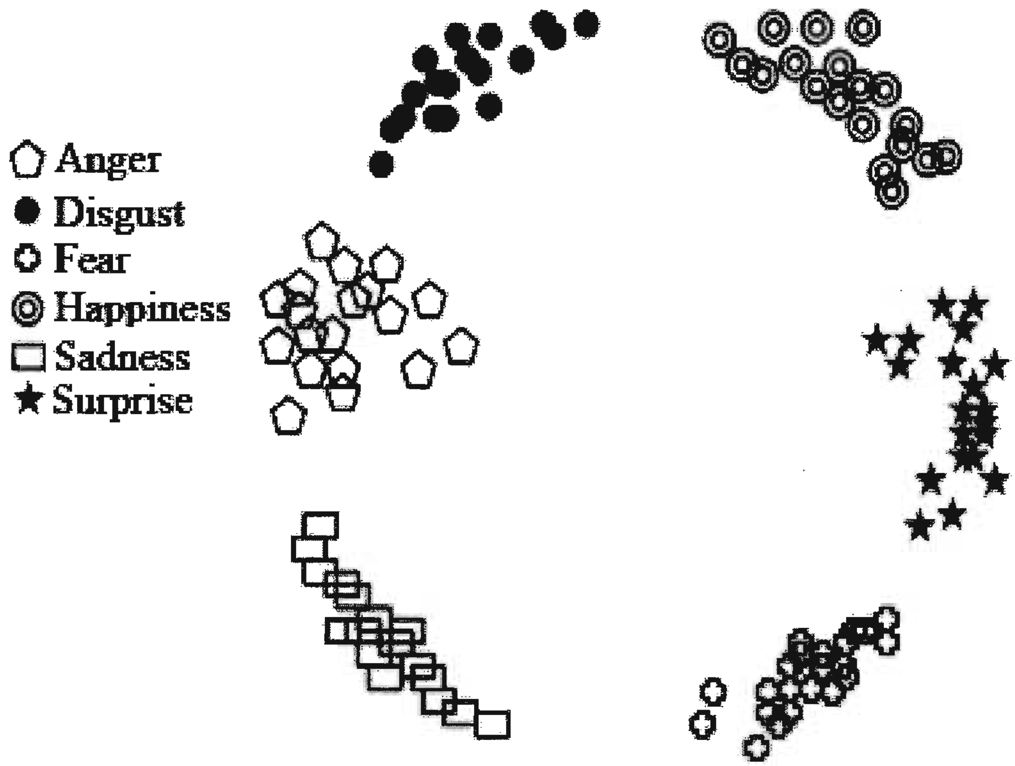

Figure 2. Adapted from Susskind, Littlewort, Bartlett, Movellan and Anderson (2007). Computer recognition of the basic facial expressions based on the physical information provided in each facial expression. This categorization by computers is comparable to that of human adults. The distance between each expression type reflects the physical similarity between the expressions.

contains some physical characteristics in common with one or more different (secondary) expressions (e.g., the furrowed brows common to disgust and anger). When the face is presented in isolation or in a congruent context these 'seeds' remain dormant; however, when the face is presented in a context that is incongruent with these 'seeds', adults may perceive that secondary emotion (i.e., in a context conveying anger, a face displaying disgust may be categorized as angry). As suggested by Aviezer et al. (2008a), context may influence the extent to which a face displaying anger is ambiguous; an angry face may be less ambiguous in a context depicting anger or happiness, and more ambiguous in a context depicting fear.

In daily social interactions, facial expressions are likely to be congruent with body posture and other types of contexts (e.g., tone of voice), and thus the perceiver typically benefits from the influence of context on the perception of facial expressions. However, in social situations in which individuals attempt to conceal their emotions (e.g., to avoid hurting others' feelings or to deceive another) they typically expend more effort to censor and disguise their facial expression than their emotional body posture; thus, in these situations the facial expression and emotional body posture will be incongruent and emotional body posture may provide the more reliable cue to the target's emotional state (Ekman & Friesen, 1982). By presenting facial expressions in both congruent and incongruent contexts in the lab, we can directly examine the influence of emotional context on adults' and children's perception of facial expressions.

The Influence of Context on Perception of Facial Expressions

In social interactions faces are typically observed within the context of a whole body and other contextual cues; thus it is surprising that the influence of emotional body postures on the recognition of facial expressions was not investigated until 2005 by Meeren, van Heijnsbergen & de Gelder. Adults can accurately and rapidly recognize emotions displayed by body postures when directly attending to the body (de Meijer, 1989; Hadjikhani & de Gelder, 2003; Schlindler, Van Gool & de Gelder, 2008) and when not directly attending to the body (for a review see de Gelder, 2006). In fact, adults may be as accurate at recognizing basic emotions displayed by bodies as they are at recognizing those same emotions in the face (Sinke, Kret, & De Gelder, 2010). Thus, based on the tenants of the Dimensional theory, emotional information displayed by the body should influence the perception of facial expressions. Specifically, when emotional information in the face and body are congruent the body may provide additional cues that enhance recognition of the facial expression; conversely, when the emotional information in the face and body are incongruent the body may impair recognition of the facial expression.

In the first study of its kind, Mereen, van Heijnsbergen, & de Gelder (2005) asked adults to make two-alternative forced-choice judgments of fearful versus angry facial expressions that were presented within congruent (e.g., a fearful face on a body displaying fear) and incongruent (e.g., a fearful face on a body displaying anger) contexts. As with other studies examining the influence of context on the perception of facial expressions, the stimuli were briefly presented (200 ms) requiring participants to judge the faces based on first impressions. Despite being instructed to ignore the body, a congruency effect was found; adults were less accurate ($M = .67$) and slower ($M = 840$ ms) on incongruent than congruent trials ($Ms = .81$ and 740 ms). Furthermore, the congruency effect was reflected in the occipital P1 component, with larger P1 amplitude for incongruent stimuli. Electrophysiological evidence of early processing in conjunction with short stimulus presentation times (200 ms) suggests that the congruency effect reflects rapid holistic processing of stimuli rather than conscious appraisal of emotions and post-perceptual decision-making (de Gelder, 2006).

As recent studies show, a variety of contexts influence the recognition of facial expressions: Emotional background scenes (Righart & de Gelder, 2008a; 2008b), voices (de Gelder, Bocker, Tuomainen, Hensen & Vroomen, 1999; de Gelder & Vroomen, 2000; Van den Stock, Rigart & de Gelder, 2007), hand movements (Hietanen & Leppanen, 2008), words (Lindquist, Barret, Bliss-Moreau & Russell, 2006) and other emotional faces (Masuda et al., 2008). In each study, adults were better at recognizing basic facial expressions that were presented in emotionally congruent contexts (e.g., happy face with happy body, voice) than emotionally incongruent contexts (e.g., happy face with sad body, voice). Thus, the effect of context on the perception of facial expressions appears to be ubiquitous.

As predicted by the Dimensional theory and the Emotional Seed model, at least two factors appear to modulate the size of the congruency effect. First, the influence of body posture varies as a function of the similarity between the emotion conveyed by the context and the emotion expressed by the face. Aviezer et al. (2008b) showed adult participants facial displays of disgust paired with emotional contexts that were highly similar (anger), not at all similar (fear) and somewhat similar (sad). Adults' recognition of disgust was not impaired by the least similar context, but was especially impaired by the most similar context. In fact, when the disgust facial expression was presented in a context conveying anger (the emotion most perceptually similar to disgust), participants were just as likely to say the facial expression was showing anger as disgust (Aviezer et al.). Second, the magnitude of the congruency effect may be larger when the facial expression is ambiguous either because the expression itself is not prototypical or because it is not easily accessible (e.g., when viewed from a distance). For example, Van den Stock et al. (2007) showed adults both morphed expressions (e.g., happy blended with fear) and pure expressions (e.g., 100% fear) paired with congruent and incongruent body postures. The congruency effect was larger for blended facial displays, with the largest effect occurring for the 50/50 blend.

Does Context Influence Children's Perception of Emotional Expressions?

To the best of our knowledge, no research has investigated whether or not body posture influences children's perception of emotional facial displays. Although the influence of context on the *perception* of facial expressions has not been studied, social psychologists have found that emotional context (e.g., story with emotional content) influences the post-perceptual *attributions* that both adults and children make about facial expressions. When both adults and elementary school-aged children were presented with a brief verbal story associated with one basic emotion and then shown a photograph of a face displaying that same emotion or a different emotion and given unlimited time to decide how the target individual was feeling, they consistently chose the emotion described in the story Carroll & Russell, 1996; 1997; Gnepp, 1983; Reichenbach & Masters, 1983). The studies described above provide evidence that adults' and children's attributions of emotions were influenced by the context; they accurately perceived the emotion conveyed both by the facial expression and the story and then used one of several cognitive strategies (e.g., elaborating on the story) in order to reconcile conflicting cues (Reichenback & Masters, 1983). This effect of context for emotional attributions is limited to conditions in which the emotions conveyed by the story and facial expression are similar (e.g., fearful and angry) (Carroll & Russell, 1996). Because children appear to be sensitive to the underlying dimensions of valence and arousal (for a review see Widen & Russell, 2003; 2008a), we predicted that their *perception* of facial expressions would also be influenced by body posture—particularly when the emotion conveyed by the face and the body posture were similar in one or more dimensions. In the first experiment, adults and 8-year-old children were asked to make 2-alternative forced-choice judgments for rapidly presented fearful and sad facial expressions presented within congruent (e.g., sad face on a body posing sadness) and incongruent (e.g., sad face on body posing fear) contexts. We elected to use sad and fearful faces for several reasons. First, children typically learn to recognize and accurately label sadness prior to most of the other negatively-valenced emotions (anger is sometimes acquired before sadness). Thus, we were quite confident that the emotional message conveyed by the face in the absence of any context would be clear (see Carroll & Russell, 1996 for similar logic in their choice of expressions when testing adults). Second, sadness and fear are both negatively valenced and share high levels of physical similarity (Susskind et al., 2007; see figure 2). Based on the Dimensional theory and the Emotional Seed model, we predicted that emotional context would influence children's recognition of the facial expression. In the second experiment, we tested adults and 8-year-old children with a new pair of facial expressions: sad and happy. We elected to use sad and happy facial expressions because children readily distinguish happy and sad facial expressions (Widen & Russell, 2008a) and these expressions are physically distinctive (Susskind et al., 2007) and vary in both arousal and valence (Russell & Bullock, 1984; 1985). We predict that the influence of context on the perception of happy and sad facial expressions for both adults' and 8-year-olds' recognition would be either small or absent.

Mechanisms Underlying the Perception of Facial Expressions

Aviezer et al. (2008b, Experiment 3) demonstrated one mechanism by which context influences adults' perception of facial expressions—attentional bias. Eye-tracking studies have found that adults' fixation patterns vary as a function of the facial expression viewed (Wong, Cronin-Golomb, & Neargrader, 2005). For example, adults fixate more on the eye and eyebrow region than the mouth when viewing angry facial expressions, whereas they fixate equally on the eye and mouth regions when viewing disgust expressions. Aviezer et al. found that context modulates these scanning patterns. When adults viewed facial expressions that were incongruent with the context expressions (e.g., disgust facial expression and anger context), their fixation patterns reflected the emotion represented by the *context* (e.g., anger) rather than the facial expression (e.g., disgust).

In the current series of studies we examined another potential mechanism driving the congruency effect—holistic processing. Unlike objects (Biederman, 1987), faces are processed holistically (i.e., the features of the face are integrated into a Gestalt) (Tanaka & Farah, 1993). A common methodology used to test for holistic processing is the composite face effect (Young, Hellawell & Hay, 1987). Both adults and children as young as 4 - 6 years of age find it difficult to recognize the top half of a face when it is aligned with the bottom half of a different face. This happens because holistic processing fuses the identities together creating a new face. Holistic processing prevents the perceiver from selectively attending to one part of the compound image (e.g., the relevant top versus the irrelevant bottom). Disrupting holistic processing by misaligning the top and bottom half of the image allows perceivers to attend to the target part (the top half) and ignore the irrelevant part (the bottom half) (Carey & Diamond, 1994; de Heering, Houthuys & Rossion, 2007; Hole, 1994; Le Grand, Mondloch, Maurer & Brent, 2004; Young et al., 1987).

Recent studies provide evidence of holistic processing for the recognition of facial expressions (Calder, Young, Keane & Dean, 2000). Calder et al. (2000) created compound images in which the top half of each face displayed a different emotion than the bottom half. Adult (Calder et al., 2000; Cottrell, Branson & Calder, 2002) and child participants as young as five years of age (Durand et al., 2007) showed evidence of holistic processing of facial expressions: despite being instructed to ignore the bottom half, they performed worse on aligned than misaligned trials. For example, when the top half of a fear expression was aligned with the bottom half of a disgust expression, participants were slower to respond and more likely to say the facial expression is showing disgust than fear. To our knowledge, Durand and colleagues (2007) were the first to provide evidence that children, as young as 5 years of age, process facial expressions holistically. Collectively, these studies provide evidence that adults and children automatically process faces as a whole image and are unable to selectively attend to identity or emotional information in one part of the face (e.g., the top half of the face) while ignoring the other half.

Does Holistic Processing Underlie the Influence of Body Posture?

De Gelder and colleges have suggested that the rapid influence of context on adults' perceptions of emotional body postures provides evidence of holistic processing of emotion simultaneously conveyed by the face and body (e.g., Meeren et al., 2005). To directly determine whether holistic processing underlies the influence of body posture on facial expressions in the current set of studies, we used a modified version of the composite face task. On half of the trials, faces and bodies were aligned and on half of the trials they were misaligned. If holistic processing underlies the congruency effects, then in the incongruent condition participants should perform better (on both accuracy and reaction time measures) on misaligned trials than on the aligned trials. No such benefit should be observed on congruent trials. To our knowledge, no previous study has directly examined the role of holistic processing in the influence of context on the perception of facial expressions.

Experiment 1: Influence of Emotional Body Postures on 8-Year-Olds' Recognition of Prototypical Fearful and Sad Facial Expressions

To examine the influence of emotional body postures on adults' and 8-year-olds' recognition of facial expressions, participants were shown photographs of individual males and females displaying facial expressions and emotional body postures. In the present experiment, fearful and sad expressions were used. All participants completed both congruent trials, in which the emotions conveyed by the face and body were the same (e.g., sad face on a sad body), and incongruent trials, in which the emotions conveyed by the face and body were not the same (e.g., fear face on a sad body). On all trials, both adults and 8-year-olds were asked to ignore the body and decide which of two emotions the face was displaying. Accuracy (proportion of trials correct) and reaction times were recorded. The influence of emotional body posture on perception of facial expressions would be evident if the participants had higher accuracy and/or quicker reaction time for congruent versus incongruent trials; this pattern of results would indicate that participants had difficulty ignoring the body expression on the incongruent trials and benefited from the information in the body on congruent trials. To examine the possibility of holistic processing as a mechanism underlying congruency effects, the influence of misalignment on adults' and 8-year-olds' recognition of sad and fear facial expressions for both congruent and incongruent trials was examined.

Method

Participants. Undergraduate students between the ages of 18 and 28 years (M = 21.6 years, 10 female) and 8-year-old children (M = 8.1 years, 6 female) participated in Experiment 1a (n = 16 participants per age group). Adults received partial course credit or a small monetary reward for their participation. Children were recruited from local elementary schools and from a community database. All participants were Caucasian, right-handed and had normal or corrected-to-normal vision (see Appendix 1 for a report of the errors associated with the visual screening of participants in this study and the implications of these errors). Adults' handedness was measured with a questionnaire adapted from Peters (1988), which asks participants to indicate the hand most frequently used for 10 different activities (e.g., "Which hand do you use to write?"). A modified version of the hand preference questionnaire was administered to the 8-year-olds (see Mondloch et al., 2002 for details). An additional 2 participants were tested but were excluded from the final analyses either because they did not meet the inclusion trial criteria (one 8-year-old) or did not pass the catch trials (one 8-year-old; see procedure). Failure to meet these exclusion criteria suggests an unusual deficit for recognizing facial expressions, lack of attention or a failure to understand the task.

Materials. In Experiment 1a, we utilized 12 photographs of 4 different facial identities (2 males); each model displayed a fearful, a sad, and a happy facial expression. All face stimuli were part of the validated NimStim Face Stimulus Set (Tottenham et al., 2009). The face stimuli were selected based on the validation rating information provided by Tottenham et al. (2009); each image used in the current study was accurately identified by over 80% of participants in Tottenham et al. (2009). All face images were resized to approximately 3.3cm horizontally x 4.5cm vertically and cropped such that each model's hair and face contour were similar for each expression.

In Experiment 1a, photographs of the bodies of four models (2 males) were used. Based on Schindler, Van Gool & de Gelder's (2007) validated set of emotional body postures, each model was asked to pose each of four expressions (fearful, sad, happy, and angry) in three different ways. There was variability in the position of the models' arms in all body postures (ranging from slightly to fully bent and from beside the body to above the body depending on the expression). For each expression and for all poses the models wore a black shirt, jeans and close-toed shoes; photographs were taken with an E0S20D Canon camera. The faces of the models were blurred using the Gausian blur function in Adobe Photoshop Version 8 to ensure that the only emotional information present in the stimuli was in the body postures (see Meeren et al., 2005). To validate the body stimuli set, 25 undergraduate students (M = 21.5 years) were shown these body postures individually in random order on the computer screen and asked to indicate on a score sheet which of four basic emotions listed (fearful, sad, happy, angry) was displayed by the body. Participants were shown each image three times throughout the validation experiment; each stimulus was presented for 600 ms. Accuracy was above 90% for each of the four emotions.

The compound face-body stimuli were created using Adobe Photoshop Version 8 editing software. The isolated faces and bodies (without the heads) were carefully cut out with the lasso function and fused together with the smudge function to create whole body images. Each facial identity was aligned with six congruent body postures (the two same-sexed models each posing three congruent body postures) and six incongruent body postures (for an example see Figure 3a). The compound stimuli were realistically proportioned with the face to body posture ratio approximately 1:6 (see Meeren et al., 2005). The compound face-body stimuli were centered on the screen and measured approximately 27 cm vertically. To create misaligned versions of each of the congruent and incongruent stimuli, each face was detached from the body stimulus using the lasso function and shifted approximately 2 cm to the left of the body. (See Figure 3a for examples of aligned and misaligned congruent and incongruent compound stimuli.) The catch stimuli consisted of happy facial expressions displayed by each of the four models; these happy expressions had over 90% accuracy ratings in the validation study by Tottenham et al. (2009). Happy facial expressions were presented in isolation during the training phase and during the criteria phase at the end of the procedure. Each happy facial expression was also presented with four same-sex sad body postures and four same-sex fearful body postures during both the aligned and the misaligned test trials. All isolated face images were centered on the display monitor approximately 2 cm from the top of the screen. All isolated body stimuli were displayed centered on the screen with the bottoms of the models' feet approximately 2 cm from

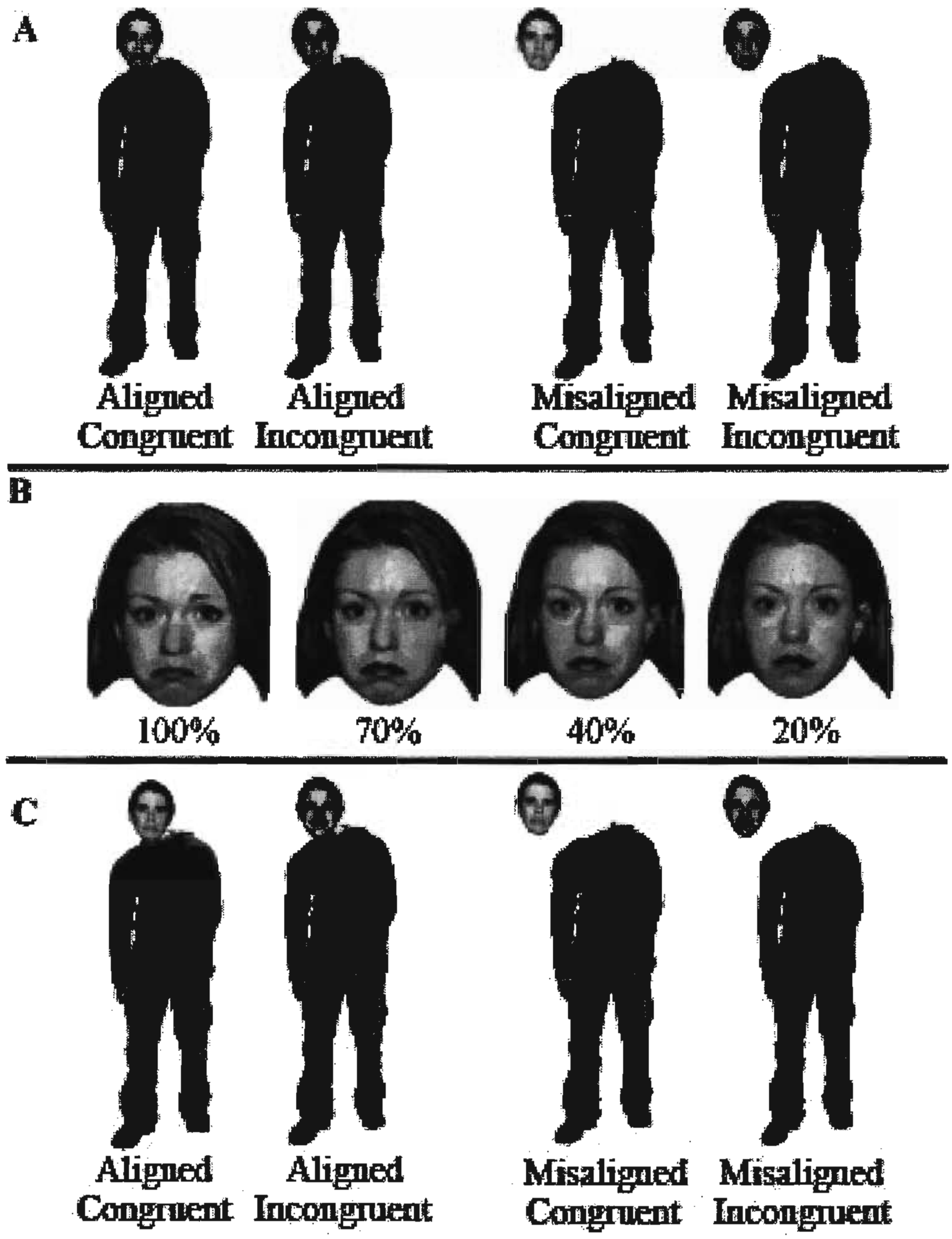

Figure 3. A: Congruent and incongruent stimuli shown during the test phases in Experiment 1a. Aligned versions are shown on the left; misaligned versions are shown on the right. Participants were told to ignore the body and indicate whether the facial expression was displaying a fearful or sad expression. B: Example of the morphed facial expressions used in Experiment 1b. Intense facial expressions were morphed with a neutral face posed by the same model in order to vary expression intensity. C: Congruent and incongruent stimuli shown during the test phases in Experiment 2. Aligned versions are shown on the left; misaligned versions are shown on the right. Participants were told to ignore the body and indicate whether the facial expression was displaying a happy or sad expression.

the bottom of the screen. Whole body aligned stimuli for the congruent, incongruent, and catch trials were also centered on the display screen.

Procedure. The procedure received clearance from the Research Ethics Board at Brock University. Written consent was obtained from adult participants and parents of the child participants prior to testing. Following visual and handedness screening procedures, participants were seated at a table 60 cm from the computer monitor in a quiet empty room either in a laboratory at Brock University or the child participants' respective schools. The task was programmed with Cedrus Superlab Version 4 and participants used a Logitech controller to indicate their responses. The controller was held in both hands and participants made their response on each trial by pressing one of the two response buttons located on the right-hand side of the controller. The right button was labeled 'F' and was always used to indicate recognition of a fearful facial expression; the left button was labeled 'S' and was always used to indicate recognition of a sad facial expression. The experimental procedures used in this study were based on Meeren et al. (2005) and prior to each block of trials verbal instructions were given while corresponding abbreviated instructions were displayed on the computer screen. On each trial throughout the procedure a fixation stimulus (*) was followed by a test stimulus (an emotional face and/or body) and then a blank screen; participants were asked to make their response when the blank screen appeared. Participants were told that this procedure would be used for each trial throughout the experiment. Similar to the procedures in Meeren et al. (2005), the fixation stimulus was located slightly above center on the screen to encourage participants to fixate on the shoulder area prior to each stimulus presentation.

The experimenter explained the instructions to the participants. They were told that they would see pictures of people who were at a party and that each guest at the party received presents; the guests either received a present they didn't like and were showing a sad face or received a present that made them frightened (e.g., a rubber snake) and were showing a fear face. The participants were told to wait until the picture had disappeared and then press the "F" button if they thought the person was showing FEAR or press the "S" button on the controller if they thought the person was showing SAD. All participants were asked to respond as quickly and accurately as possible. Following these instructions, participants completed a set of training trials to ensure that they understood the instructions and could accurately identify the isolated sad and fearful facial expressions. They completed four practice trials (two sad faces and two fearful faces) in which faces were presented for 2 seconds and then eight trials in which the isolated faces were presented for 600 ms. To meet the training criteria participants had to correctly identify six of the eight training stimuli before continuing with the experiment; each of the participants was allowed three attempts to meet the inclusion criteria. All the adults and all but one of the 8-year-old participants met the criteria and the participant who did not meet training criteria was excluded from the analyses. In the final set three adults and six 8-year-olds had to make two attempts to meet the criterion; the remaining participants met the criterion after a single attempt (see Appendix 1 regarding the errors associated with the training procedures and the implications of these errors).

Following the training session, participants completed two blocks of test trials (aligned and misaligned), the order of which was counterbalanced. Each test block consisted of 48 congruent and 48 incongruent trials. Within each block congruent and incongruent trials were randomly intermixed with each other and with 16 compound catch stimuli designed to ensure that participants were attentive to the task. Participants were required to accurately identify 13 out of 16 happy catch trials in each of the two test blocks to be included in the final analyses. The only participant who failed to meet the catch trial criteria (an 8-year-old) was excluded from analyses and replaced (see Appendix 1 for a report of the errors associated with the catch trials and implications of these errors).

Prior to both the aligned and misaligned blocks the participants completed 12 practice trials. Stimuli were presented for 2 seconds in the first four trials and for 600 ms in the following ten trials, thus allowing the participants to become familiar with the task. To introduce the aligned block the participants were told that the task was the same as the training sessions except that now they would see images of whole bodies (face and body attached). They were reminded that their task was to decide if the *face* was showing sad or fear and respond accordingly with the “S” and ”F” buttons on the controller. The importance of ignoring the body during this task was explicitly emphasized. Prior to the misaligned block participants were told that someone had played a magic trick on the guests at the party and made it look like each of the guests' heads was floating way from their body. Again, the importance of ignoring the body was emphasized and participants were told to indicate if the face was showing sad or fear. The participants who received the misaligned trials first were told prior to the aligned block that the ‘trickster’ who made it look like the heads were floating away from the bodies was caught and that all the heads would be attached to the bodies.

Throughout each test block (aligned and misaligned) there were 16 catch trials in which happy faces were presented on sad and fearful bodies (counterbalanced between gender, identity and expression). Participants were told to refrain from pressing the buttons on the controller and instead to say the word 'happy' out loud to the experimenter when they saw a person showing a happy face. Each participant was required to correctly identify 13 of the 16 happy catch trials to be included in the final analyses. The catch trials provided a fun task for the children to help maintain their interest in the task and provided us with a quantitative measure of attentiveness. One child was excluded based on the above criterion.

Participants assigned to the aligned followed by misaligned order completed an extra block of misaligned practice trials prior to the aligned trials test block. This practice set was designed to ensure that the participants, especially children, understood that their job was to ignore the body when making judgments (see Mondloch, Pathman, Maurer, Le Grand & de Schonen, 2007 for a similar strategy when testing children on a composite face task). The practice block consisted of four practice trials in which stimuli were presented for 2 seconds, followed by 20 practice misaligned trials and four misaligned catch trials in which the stimuli were presented for 600 ms. Participants who received the misaligned trials first did not complete the extra misaligned practice block before the aligned trials because they had already completed the block of misaligned trials thus had sufficient practice with this task.

Throughout the experiment the participants were praised for their good work after each set of practice trials and approximately 5 times per test block to maintain their motivation; encouragement was independent of the participants' accuracy. After the participants completed the first test block they were informed that they had completed approximately half of the experiment. At this time, to further encourage motivation, the adult participants were reminded about the importance of their role in the research and the children were reminded that they would have the opportunity to choose a present from the treasure chest to reward them for their good work. Test trials and catch trials were presented in a different random order to each participant.

After completing the aligned and misaligned blocks, participants completed a block of isolated body postures (with the faces blurred) to ensure that both the adults and 8-year-old participants were able to accurately identify the emotional body postures. Before this block began the participants were informed that the experiment was almost complete. Because participants had viewed the bodies on earlier trials and had practiced making the sad/fear response, no practice trials were included in this block. For each of the 24 isolated body trials (4 models x 2 expressions x 3 poses), the participants were asked to indicate if the body was showing a sad or a fear expression by pressing the corresponding buttons (S or F) on the controller. Participants were required to accurately identify at least 20 of the 24 emotional body postures; all participants met the criteria. Following the isolated body trials, participants completed the 16 isolated face trials; each of the four identities was shown twice with each expression (sad and fear) plus an additional 4 happy catch trials (each facial identity showing happy). Participants indicated their response of sad or fear on the controller or said ‘happy’ out loud as with the other catch trials. The isolated face trials were used to ensure that participants were able to accurately identify the facial expressions at the end of the experiment and to measure attention. Following the final block, participants (and guardians) were thanked for their time and debriefed.

Results

Criteria trials: Isolated face and isolated body trials. Prior to testing, both age groups were trained to 80% correct on isolated faces. At the end of the procedure when tested again with isolated faces, adults' accuracy remained high ($M = .93$) whereas 8-year-olds' accuracy decreased ($M = .68$), although they successfully detected at least three of four catch trials. Both adults ($M = .99$) and 8-year-olds ($M = .90$) were very accurate when judging isolated emotional body postures. The accuracy levels for adults' recognition of isolated emotional body posture were similar to those reported in the literature (Meeren et al., 2007; Schindler et al., 2007).

Influence of congruency on accuracy. The primary question addressed in the current study was whether adults' and 8-year-olds' recognition of facial expressions would be influenced by the expressions displayed by the body when the face and body were aligned; thus the primary analyses included aligned stimuli only. For each participant the number of trials on which they selected the correct facial expression was calculated for both congruent and incongruent trials. A 2 (age: 8-year-olds and adults) x 2 (congruency: congruent and incongruent trials) repeated measures ANOVA was conducted to determine whether accuracy scores on aligned trials differed as a function of congruency and age. Overall, participants were more accurate on congruent than on incongruent trials (see Figure 4), F (1, 30) = 54.45, p <.001, $\eta^2 = .645$. A significant main effect of age was also found, F (1, 30) = 34.28, p <.001, $\eta^2 = .533$; overall adults were more accurate than 8-year-olds. There was a significant age x congruency

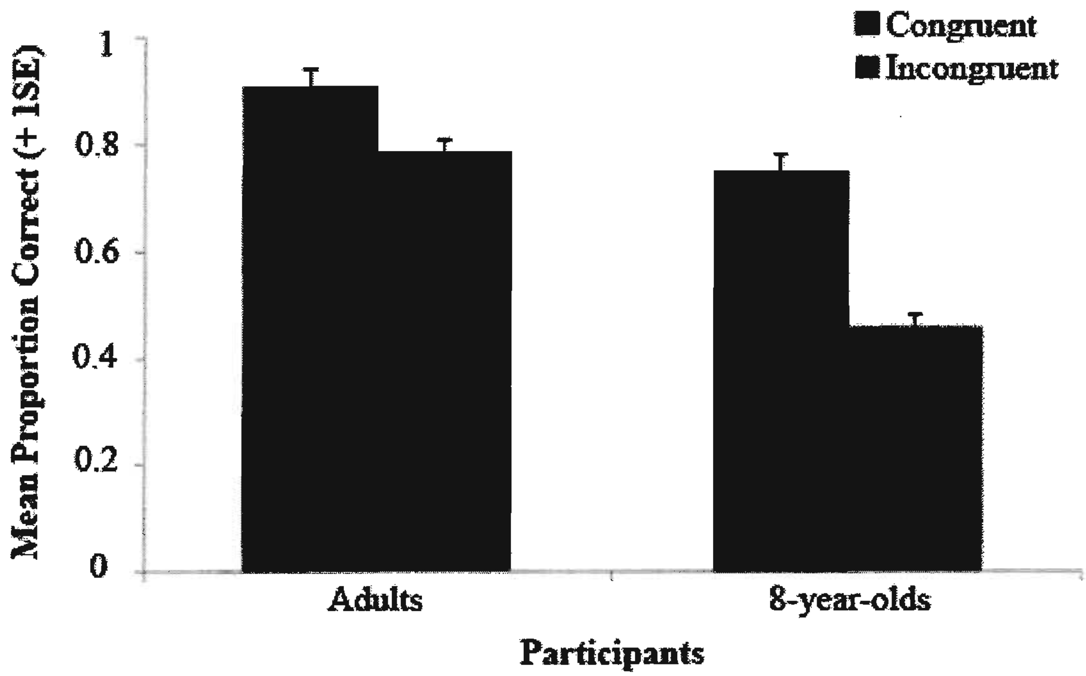

Figure 4. Adults' and 8-year-olds' mean proportion correct for aligned congruent and incongruent trials in Experiment 1a. The participants were asked to ignore the body and indicate whether the facial expression was displaying a fearful or sad expression.

interaction, $F(1, 30) = 9.01, p <.010, \eta^2 = .231$. Thus, accuracy scores on aligned trials varied as a function of the whether the facial expressions and emotional body postures were congruent or incongruent and the magnitude of this effect depended on the age of the participant (see Figure 4). Separate one-tailed paired sample *t*-tests were conducted for each age group to determine whether accuracy scores differed on congruent compared to incongruent trials. Adults' accuracy was significantly better on congruent trials ($M = .91$) than on incongruent trials ($M = .79$), $t(1, 15) = 4.95$ $p < .001$. Similar to adults, 8-year-olds' accuracy was significantly better on congruent trials ($M = .75$) than on incongruent trials ($M = .45$), $t(1, 15) = 5.79, p < .001$. Importantly, a two-tailed independent t-test revealed that the magnitude of the congruency effect—accuracy on incongruent trials subtracted from accuracy on congruent trials—was significantly larger for 8-year-olds ($M = .30$) than for adults ($M = .12$), $t(1, 30) = 3.00, p < .010$. An analysis of residuals revealed that this age difference is not a function of participants' variability in accuracy on congruent trials.

The primary analysis revealed that both adults' and 8-year-olds' recognition of facial expressions was influenced by the expressions displayed by the body but not whether the influence of a sad body on perceptions of a fearful face differed in magnitude from the influence of a fearful body on perceptions of a sad face. An additional analysis was conducted to determine whether the influence of context differed as a function of the facial expression displayed in the stimuli (e.g., sad versus fearful facial expressions). This analysis is important because although fearful and sad expressions are both negative, they vary in their levels of arousal and associated locations on the circumplex model (see Figure 1). Specifically, fearful facial expressions are located in the dense, high arousal/negative area of the circumplex, whereas sad facial expressions are located in the less dense, low arousal/negative area of the circumplex. Proponents of the Dimensional theory suggest that fearful facial expressions are more ambiguous, thus more susceptible to context effects, than sad facial because of their respective locations on the circumplex model (see Figure 1). To examine this prediction separate paired sample t-tests were conducted for each age group comparing the difference between participants' accuracy on the congruent and incongruent trials for sad and fearful trials. The magnitude of children's congruency effects did not significantly differ between the facial expressions, $t(1, 15) = .154, p = .879$. Similarly, the magnitude of adults' congruency effects did not significantly differ between the facial expressions, $t(1, 15) = .323, p = .751$. Thus, for both children and adults perception of sad and fearful facial expressions were influenced by the emotional body contexts to a similar degree. Overall, this analysis provides evidence that the density of the quadrant in the circumplex in which the emotion is located does not influence the magnitude of the congruency effect.

Although the primary comparison was between congruent and incongruent trials, the isolated face trials at the end of the procedure provided an opportunity to determine the extent to which congruent bodies facilitate the perception of emotional facial expressions and the extent to which incongruent bodies impair that ability, relative to when faces are presented in isolation. To examine if adults and 8-year-olds benefited from congruency, a two-tailed paired samples *t*-test was conducted for each age group in which accuracy on the isolated face block was compared to accuracy on the congruent trials. Adults' performance did not differ on the congruent trials ($M = .91$) versus isolated face trials ($M = .93$). However, 8-year-olds did benefit from congruency; their accuracy was significantly better on congruent trials ($M = .75$) than on the isolated face trials ($M = .68$), $t(1, 15) = 2.65, p < .001$. These results suggest that 8-year-olds used the expression cues in the body to assist with their identification of the facial expression. To examine if adults and 8-year-olds were disadvantaged by incongruency, a two-tailed paired samples *t*-test was conducted for each age group comparing accuracy in the isolated face block to accuracy in the incongruent block. Adults were disadvantaged by incongruency; accuracy scores were significantly worse on incongruent trials ($M = .79$) than on isolated face trials ($M = .93$), $t(1, 15) = 3.78, p = .002$. Eight-year-olds were also disadvantaged by incongruency; accuracy scores were significantly lower on incongruent trials ($M = .46$) than isolated face trials ($M = .68$), $t(1, 15) = 5.16, p < .001$.

Influence of congruency on reaction time. Analyses of median reaction times on correct trials confirmed that differences in accuracy scores could not be attributed to speed-accuracy trade-offs. A 2 (age: 8-year-old and adults) x 2 (congruency: congruent and incongruent) repeated measures ANOVA revealed a significant main effect of congruency, $F(1,30) = 11.83, p < .05, \eta^2 = .283$. Both adults and 8-year-olds responded more quickly on congruent trials (*Ms* = 1183 ms and 1403 ms, respectively) than on incongruent trials (*Ms* = 1259 ms and 1502 ms, respectively), suggesting that both age groups' identification of facial expressions is impaired by incongruent emotional body postures. A significant main effect of age revealed that adults were quicker than 8-year-olds on both congruent and incongruent trials, $F(1,30) = 4.98, p < .05, \eta^2 = .142$. There was no interaction between congruency and age, $p > .50$.

Effects of alignment. To examine the effect of alignment on the magnitude of congruency effects, the alignment effect (accuracy on aligned trials subtracted from accuracy on misaligned trials) was calculated separately for congruent and incongruent trials. It was hypothesized that there would be an alignment effect (better accuracy on misaligned trials) on incongruent trials but not on congruent trials. A 2 (age: 8-year-olds and adults) x 2 (congruency: congruent and incongruent trials) repeated measures ANOVA revealed a significant main effect of congruency, $F(1,30) = 26.64$, $p < .001$, $\eta^2 = .470$. As shown in Figure 5, the alignment effect was present only on incongruent trials. The alignment effect did not significantly differ as a function of age, $p > .20$, however, there was a significant congruency x age interaction, $F(1,30) = 7.38$, $p = .011$, $\eta^2 = .197$. This interaction suggests that effect of misalignment varies as a function of the congruency of the trials and that the magnitude of this effect varies with age. An independent *t*-test revealed that on incongruent trials the alignment effect was larger for 8-year-olds ($M = .16$) than adults ($M = .05$), $t(1, 30) = 2.38$, $p < .05$. Single samples *t*-tests (two-tailed) comparing the magnitude of the alignment effect for each age group to the null hypothesis value of zero revealed a significant alignment effect on incongruent trials for 8-year-olds, $t(1,15) = 4.17$, $p < .001$, but not for adults, $p > .05$ (see Figure 5a). Likewise, on congruent trials there was a significant alignment effect for 8-year-olds, $t(1,15) = -3.08$, $p < .01$, but not for adults, $p > .15$ (see Figure 5b). However, as shown in Figure 5a, although children were less accurate than adults on aligned incongruent trials an analysis of residuals revealed that there is no difference in the magnitude of the alignment effect between age groups when variability in participants' accuracy on aligned incongruent trials is controlled for. Thus, regardless of age, participants who were less accurate on incongruent trials benefited more from misalignment than those who had higher accuracy on incongruent trials.

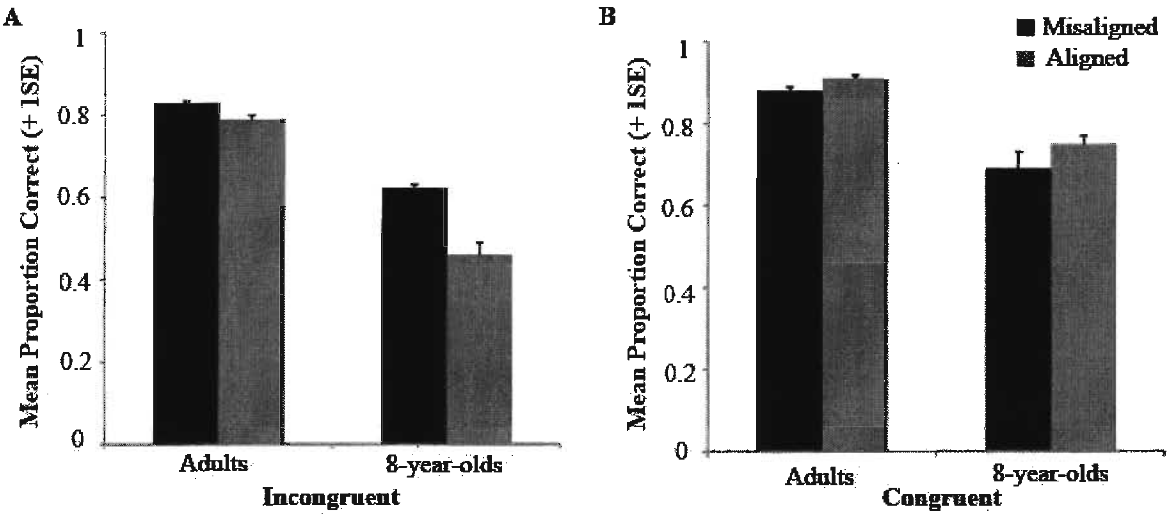

Figure 5. A: Adults' mean proportion correct for misaligned and aligned trials in Experiment 1a when the facial expression and body posture were incongruent (A) and when the facial expression and body posture were congruent (B). Higher accuracy on misaligned trials is consistent with holistic processing.

Discussion

The results of our study are the first to indicate that children's perceptions of facial expressions are influenced by emotional context. Like adults in the current experiment and like adults in previous studies (Aviezer et al., 2008b; Mereen et al., 2005; Van den Stock et al., 2007) children were more accurate and faster to identify facial expressions when the face and emotional body postures were congruent than when the face and emotional body postures were incongruent. The magnitude of the congruency effect found for adults (12%) is consistent with that found by Meeren et al., (2005; 14%) in a study using similar methods and face and emotional body postures that were not only similar in valence, as in our study, but also similar in arousal levels (i.e., angry and fearful expressions). The congruency effect did not differ by expression type (e.g., the size of the congruency effects did not differ when the facial expressions were sad or fearful for either age group).

Children differed from adults in two ways. First, adults were more accurate and quicker to respond than 8-year-olds. In addition, children had a significantly larger congruency effect than adults (30% versus 12%). The pattern of results found in the current study suggests that body posture had a larger influence on the 8-year-olds' recognition of facial displays of emotion than that of adults.

Experiment 1a was also the first study, to our knowledge, to directly explore the possibility that emotional information conveyed by face and emotional body postures may be perceived holistically. Although our results suggest that 8-year-olds benefited from misalignment on incongruent trials and adults did not, an analysis of residuals revealed that the difference in the extent to which adults and children benefit from the misalignment on incongruent trials is attributable to the variability of participants' performance on the aligned incongruent trials rather than age per se.

There are two plausible interpretations of the current data. First, the results may provide weak evidence of holistic processing. One possibility is that 8-year-olds and some adults process facial expressions and emotional body postures holistically. These participants may have formed a gestalt on aligned trials, a strategy that would decrease accuracy and increase the benefit of misalignment. Alternatively, rather than reflecting holistic processing, the alignment effects may suggest that some participants performed poorly on incongruent aligned trials because they did not ignore the body. Misalignment of the face and body increased the distance between them and allowed the participants who were attending to the body to more easily ignore the body and selectively attend to the face expressions, thus improving their performance.

Although the current study provides novel contributions to the literature on the perception of emotional expressions, an important question is left unanswered: What is driving the difference in the magnitude of the congruency effects for adults compared to 8-year-olds? In the current study we controlled for two possible explanations. First, all participants correctly identified the happy facial expressions on at least 80% of all catch trials suggesting that the difference in the magnitude of congruency effects for adults and 8-year-olds cannot be attributed to the 8-year-olds' lack of attention to the facial expression. If the 8-year-olds did not correctly identify the catch trials then this would suggest that they were not attending to the facial expressions and were using the body alone to provide information about the target's emotional expression. In face perception research, catch trials are often used to ensure that both adults and children attend to the target stimuli (e.g., Vida & Mondloch, 2009). Second, in the current study we also established that the larger congruency effect for children is not a function of variability in accuracy on congruent trials.

In Experiment 1a, one possible explanation for the larger congruency effect for 8-year-olds is that 8-year-olds found the task more difficult than adults. It is well established that children's sensitivity to facial expressions develops gradually and that children are not adult-like for some expressions until 10-12 years of age (Camras & Allison, 1985; De Sonneville et al., 2002; Durand et al., 2007; Kolb, Wilson & Taylor, 1992; Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000; Widen & Russell, 2003). By approximately 5 years of age, children have adult-like accuracy and sensitivity thresholds for happy expressions and by 7 years of age they have adult-like accuracy for sad. However, adult-like sensitivity to fear develops at approximately 10 -12 years of age (Gao & Maurer, 2009). Without adult-like sensitivity to fearful expressions, the 8-year-old children (even though trained to 80% levels of accuracy prior to the experiment) may have perceived the fearful expressions as more ambiguous than adults and thus relied on emotional information from the context (e.g., emotional body postures) to help them identify the facial expression. Thus, the 8-year-old children may have had a larger congruency effect than adults because of the perceived ambiguity of the facial expressions used in the study. A recent study found that adults had a larger congruency effect when the facial expressions were manipulated to be ambiguous. Van den Stock et al. (2008) varied the ambiguity of the target expression by morphing pairs of emotions in five steps: 100% prototypical fear, 75% fear and 25% happy, 50% fear and 50% happy, 75% happy and 25% fear, and 100% prototypical happy. The congruency effect was largest when the stimuli were most ambiguous (i.e., 50% fear, 50% happy). Based on this previous study, in a follow-up experiment (Experiment 1b) we examined the influence of task difficulty on the size of adults' congruency effects: the facial expressions were made more ambiguous for adults by varying the intensity of the facial expressions (e.g., fear and sad) by morphing each intense expression with a neutral expression posed by the same model.

Experiment 1b: The Influence of Intensity of Facial Expression on Adults' Congruency Effects

As in Experiment 1a, adult participants completed a forced choice facial expression recognition task with congruent and incongruent trials. However, in the current experiment each participant judged faces at one of four levels of intensity: 100% prototypical expressions, 70% expressions – 30% neutral expressions, 40% expressions – 60% neutral or 20% expression – 80% neutral expressions (very subtle expressions). The subtle expressions were designed to make the faces ambiguous similar to the ambiguity of the blended facial expressions used by Van den Stock et al. (2007), thus decreasing adults' overall performance (i.e., decreasing accuracy and increasing reaction time). One possibility is that doing so would increase the influence of context. If 8-year-olds' larger congruency effect is attributable to greater perceived ambiguity of the facial expressions then the less emotional information conveyed by the face, the more the adults will rely on the emotional body postures to identify the facial expressions. Such a pattern of results would be consistent with those of Van den Stock et al. Alternatively, if 8-year-olds' larger congruency effect is not attributable to greater perceived ambiguity then the magnitude of adults' congruency effects will be unaffected by expression intensity.

Method

Participants. Participants in Experiment 1b were 64 adult undergraduate students between the ages of 18 and 26 (M = 20.1 years, 46 female). All participants were Caucasian and met the handedness preference and visual criteria established in Experiment 1a (see Appendix 1 for a report of the errors associated with the visual screening criteria and the implications of these errors). Four additional adults were tested but excluded from the analyses because they failed to pass the catch trial criteria (See Appendix 1 for details regarding the errors associated with catch trials). Each of the 64 participants was randomly assigned to one of four versions of the task; version differed only in the intensity of the emotional facial expressions.

Materials and Procedure. The stimuli used in Experiment 1b were the same as those used in Experiment 1a except that the amount of emotion (intensity) in the face stimuli differed for each of the 4 versions of the task (100%, 70%, 40% and 20% versions, see Figure 3b). For each facial identity we used Norrkross MorphX (see http://www.norrkross.com for details) software to morph the intense 100% emotional faces with a neutral face (0% emotion) of the same identity to create four levels of intensity. For example, faces in the 70% version were blends of 70% sad/fear expressions and 30% neutral expressions. The face stimuli used in the catch trials were the same stimuli (100% expression) used in Experiment 1a. The instructions and procedures for Experiment 1b were identical to that of Experiment 1a for each version of the experiment (see Appendix 1 for a report of the errors associated with the training trials and the catch trials for this experiment and the implications of these errors).

Results

Criteria trials: Isolated face and isolated body trials. A one-way ANOVA revealed a significant main effect of intensity; adults' accuracy for isolated face expressions at the end of the procedure varied with intensity of the expression presented in the face, $F(1, 60) = 3.88, p < .02$. Post hoc Dunnett's t-tests revealed that adults' accuracy was significantly higher on the 100% intensity version ($M = .89$) than the 20% intensity version of the task ($M = .67$), but not significantly higher than the 70% and 40% versions of the task (*Ms* = .90 and .76 respectively). As in Experiment 1a, adults' accuracy on isolated bodies was high (*Ms* > .93) in all versions of the experiment.

Influence of congruency on accuracy. Similar to Experiment 1a, the primary analyses included aligned stimuli only in each version of the experiment. For each participant the number of trials on which they selected the correct facial expression was calculated for both congruent and incongruent trials. A 4 (intensity: 100%, 70%, 40%, 20%) x 2 (congruency: congruent and incongruent trials) repeated measures ANOVA was conducted to determine whether accuracy scores on aligned trials differed as a function of congruency and intensity. A significant main effect of congruency was found, $F\ (1, 30) = 70.85, p <.001, \eta^2 = .541$; adults were more accurate on congruent than incongruent trials (see Figure 6). A significant main effect of intensity was also found, $F\ (1, 30) = 12.23, p <.001, \eta^2 = .379$. Dunnett's t-tests comparing accuracy at each level of intensity to accuracy at 100% intensity confirmed that adults' accuracy on congruent trials was significantly lower at the 20% intensity level (M diff = .218, $p < .001$) and at the 40% intensity level, (M diff = .107, $p < .05$), but not at the 70% intensity level (M diff = .006, $p > .05$). Nonetheless, as shown in Figure 6, there was no interaction between congruency and intensity, p > .50. The magnitude of the congruency effect ranged from 9% to 15% across all levels of intensity despite adults' accuracy on congruent trials at 20% intensity ($M = .66$) and at 40% intensity ($M = .80$) being comparable to that of the 8-year-olds' in Experiment 1a ($M = .75$).

Influence of congruency on reaction time. Analyses of median reaction times on correct trials confirmed that differences in accuracy scores could not be attributed to speed-accuracy trade-offs. To examine if participants' reaction times varied as function intensity and congruency, a 4 (intensity: 100%, 70%, 40%, 20%) x 2 (congruency: congruent and incongruent) repeated measures ANOVA was conducted. Across all versions of the task adults responded more quickly on congruent than incongruent trials, $F(1,30) = 22.94, p < .001, \eta^2 = .277$. There was no significant main effect of intensity and no congruency x intensity interaction, *ps* > .05.

Effects of alignment. A 4 (intensity: 100%, 70%, 40%, 20%) x 2 (congruency: difference scores for congruent and incongruent trials) repeated measures ANOVA revealed a significant main effect of congruency, $F(1,30) = 54.14$, $p < .001, \eta^2 = .460$. The effect of alignment was only present for the incongruent trials. There was no significant effect of intensity and no congruency x intensity interaction, *ps* > .05. Thus, as shown in Figure 7, the magnitude of the alignment effect did not increase as the intensity of the facial expressions decreased. Unlike in Experiment 1a, single sample t-tests (two-tailed) revealed that each group of adults performed better on incongruent trials when faces and bodies were misaligned than when faces and bodies were aligned, although the

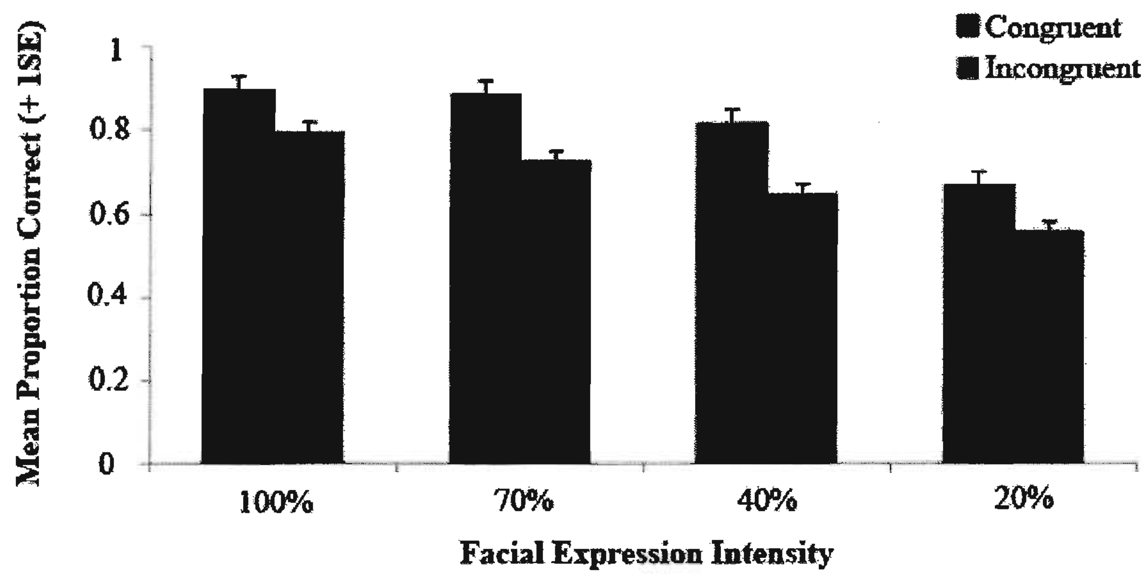

Figure 6. Adults' mean proportion correct for aligned congruent and incongruent trials for each level of facial expression intensity in Experiment 1b. The participants were asked to ignore the body and indicate if the facial expression was displaying a fearful or sad expression.

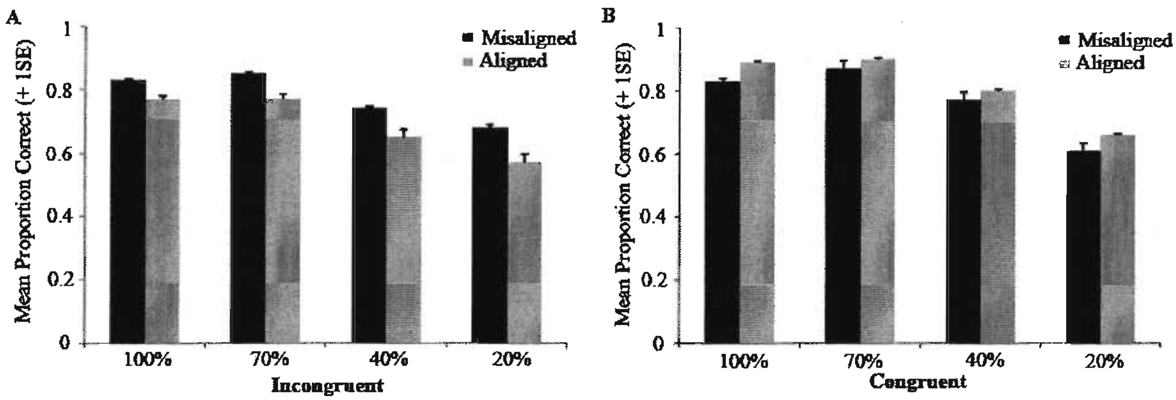

Figure 7. A: Adults' mean proportion correct for misaligned and aligned trials in Experiment 1b when the facial expression and body posture were incongruent (A) and when the facial expression and body posture were congruent (B). Higher accuracy on misaligned trials is consistent with holistic processing.

effect was only marginal in the 100% version of the task, $p = .055$ (all other $ps < .02$); the alignment effect ranged between .09 and .12 across the four task versions.

Discussion

Decreasing the intensity of the facial expressions successfully lowered adults' accuracy on congruent trials in the 40% and 20% expression conditions to a level comparable to the accuracy reported for 8-year-olds in Experiment 1a. Despite perceiving the facial expressions in the 40% and 20% conditions to be more ambiguous than prototypical expressions, the magnitude of the congruency effect did not increase. Effects of congruency across all conditions were comparable to those reported in Experiment 1a, suggesting that the difference between children's and adults' congruency effects in Experiment 1a cannot be explained by 8-year-olds finding the facial expressions to be ambiguous (i.e., because of the gradual development of sensitivity to fearful expressions).

Unlike the results in the current study, Van den Stock et al. (2007) found that the more ambiguous the facial expressions were the greater the adults' congruency effect. A key difference between our work and that of Van den Stock and colleagues is that they blended two intense facial expressions (happy and fear) whereas we blended one intense expression (sad or fear) with a neutral expression. According to the Dimensional theory (e.g., Russell, 1985) and the Emotional Seed theory (Aviezer et al., 2008a) these two manipulations may have very different effects. Reducing the intensity of the expression (as in Experiment 1b) should not affect the underlying dimensions or qualitatively change the quasi-physical characteristics displayed. In contrast, blending expressions that are different in valence, intensity and physical characteristics (e.g., fear and happy) must alter the location of the expression on the perimeter of circumplex. Our results suggest that blending two intense expressions versus one intense expression with a neutral face are not interchangeable manipulations of ambiguity.

Decreasing the intensity of facial expressions did not increase the size of the congruency effect, but did provide some evidence of holistic processing. Unlike the adults in Experiment 1a, adults tested with subtle expressions performed better on misaligned than aligned trials when the face and body were incongruent. These results suggest that when the facial expressions were not prototypical (and thus more difficult to recognize) adults may have processed the information holistically; alternatively, the participants may relied more on the body.

Although Experiments 1a and 1b suggest that children are more influenced than adults by emotional body postures, both the Dimensional theory and the Emotional Seed model predict that adults' congruency effects and age differences in congruency effects will vary as a function of the similarity of the expressions being presented (see Aviezer et al., 2008b for supporting evidence). In addition, age differences may be smaller when children are tested with expressions for which they have adult-like sensitivity. To examine this possibility, in Experiment 2 we tested adults and 8-year-olds with happy and sad facial expressions. The Dimensional theory and the Emotional Seed model both state that happy and sad expressions are highly dissimilar. The Dimensional theory emphasizes that happy and sad differ in both valence and arousal levels, whereas the Emotional Seed model emphasizes that sad and happy vary in terms of physical differences. Thus we predict that both adults and children will show a much smaller congruency effect for happy versus sad expressions compared to fearful versus sad expressions. Thus we predict that adults will show little or no congruency effect.

Developmentally, we know that children have adult-like sensitivity thresholds for happy expressions by the age of 5 and for sad expressions by the age of 7 (Vicari et al., 2000; Gao & Maurer, 2009; Kolb et al., 2006). If the larger congruency effect for children in Experiment 1a can be attributed to lack of adult-like expertise for sad and fearful facial expressions, then 8-year-olds and adults should have comparable congruency effects for happy versus sad facial expressions. In contrast, if the larger congruency effect for children in Experiment 1a reflects a general inability of children to ignore bodies, then 8-year-olds should continue to have a large congruency effect, despite being tested with emotions for which they have adult-like expertise.

Experiment 2: The Influence of Emotional Body Posture on Adults' and 8-Year-Olds' Perception of Happy and Sad Facial Expressions

In Experiment 2 adults and 8-year-olds completed the same task as in Experiment 1a except that happy and sad expressions were used instead of fear and sad. If the influence of emotional context on the perception of facial expressions is dependent on the similarity (as defined by underlying dimensions and physical characteristics) between the emotions in face and body then a congruency effect for sad and happy expressions should be small or absent. We tested participants on both aligned and misaligned trials in order to maintain consistency in experimental design, but note that the absence of a congruency effect would mathematically eliminate any effect of alignment; in order to show an alignment effect (better performance for incongruent trials on misaligned than aligned trials) the participants would need to perform worse on incongruent than congruent trials.

Method

Participants. Sixteen adult undergraduate students between the ages of 18 and 23 years (*M* = 20.2 years, 14 female) and sixteen 8-year-olds (*M* = 8.0 years, 6 female) participated in Experiment 2. All participants were Caucasian and met the hand preference and visual criteria established in Experiment 1. Three additional adults and one additional 8-year-old were tested, but failed visual screening and were excluded from the analyses. (As with the previous 2 experiments, see Appendix 1 regarding the errors associated with the visual screening, training and catch trials in this experiment).

Materials. The same facial and body identities were used as in Experiment 1. The models displayed sad and happy expressions; the compound sad face and body stimuli were the same as those in Experiment 1 (see Figure 3c). The happy body postures were based on Schindler, Van Gool & de Gelder's (2007) validated set of emotional body postures. The happy body postures were validated by 25 undergraduate students at Brock University as mentioned in Experiment 1a. The methods used to create the compound face and body stimuli were the same as in Experiment 1; facial and body stimuli were fused together to create both congruent (e.g., happy face and happy body postures) and incongruent (e.g., happy face and sad body postures) compound stimuli. The catch trials used in Experiment 2 were surprise facial expressions of the same NimStim identities used throughout the experiment. The methods used to create the misaligned stimuli set for the happy trials and surprise catch trials were the same as those described in Experiment 1. The misaligned sad images from Experiment 1 were re-used.

Procedure. The procedure for Experiment 2 was identical to that of Experiment 1 except that in the instructions the participants were told that the guests at the party either received a present they didn't like and were showing a SAD face or they received a present they did like and were showing a HAPPY face. Similar to the instructions in Experiment 1, participants were told that if they thought the guest was showing a SAD face, to press the S button and if the guest was showing a HAPPY face to press the H button. For the instructions to the catch trials, participants were told that sometimes at the party the guests received presents they didn't expect to get and were showing a SURPRISE face. When the guest was showing a surprise face the participants were told to not press any buttons and to instead say SURPRISE out-loud. The instructions for the misaligned trials and isolated emotional body postures were the same those described in Experiment 1.

Results

Criteria trials: Isolated face trials and isolated body trials. Both adults' (M = .99) and 8-year-olds' (M = .96) were very accurate when judging isolated facial expressions at the end of the procedure. When judging isolated emotional body postures, adults' and 8-year-olds's accuracy was also very high (Ms = .99 and .98, respectively).

Influence of congruency on accuracy. As in Experiments 1a and 1b, the primary analyses included aligned stimuli only. A 2 (age: 8-year-olds and adults) x 2 (congruency: congruent and incongruent trials) repeated measures ANOVA was conducted to determine if accuracy scores on aligned trails differed as a function of congruency and age. A main effect of congruency was found; unlike in Experiment 1a, 8-

year-olds and adults were more accurate on incongruent trials than congruent trials, F (1, 30) = 126.52, $p < .001$, $\eta^2 = .808$, although accuracy was very high overall (> .87). A significant main effect of age was found, $F(1, 30) = 6.43$, $p < .05$, $\eta^2 = .192$; adults were more accurate than 8-year-olds, although again accuracy was high for both age groups overall. Importantly, as shown in Figure 8, there was no interaction between congruency and age, $p > .30$. The results from Experiment 2 suggest that for dissimilar expressions the emotional information displayed in the body does not interfere with the emotional information displayed in the face. Thus, when the emotions displayed in the face and body are dissimilar on valence and congruency children and adults are not readily influenced by the context.

Influence of congruency on reaction time. A 2 (congruency: congruent and incongruent) x 2 (age: adults and 8-year-olds) repeated measures ANOVA of median reaction times revealed a significant main effect of age, $F(1,30) = 6.43$, $p < .05$, $\eta^2 = .192$. As in Experiment 1a, adults are quicker to respond than 8-year-olds. Both the effect of congruency and the interaction between congruency and age failed to reach significance, $ps > .45$.

Effects of alignment. A 2 (age: 8-year-olds and adults) x 2 (congruency: congruent and incongruent) repeated measures ANOVA revealed a significant main effect of age, $F(1,30) = 6.20$, $p < .02$, $\eta^2 = .171$ and no effects of congruency or interaction between age and congruency, $ps > .10$. Overall, the effect of alignment was very small on both congruent ($M = -.001$) and incongruent ($M = -.009$) trials.

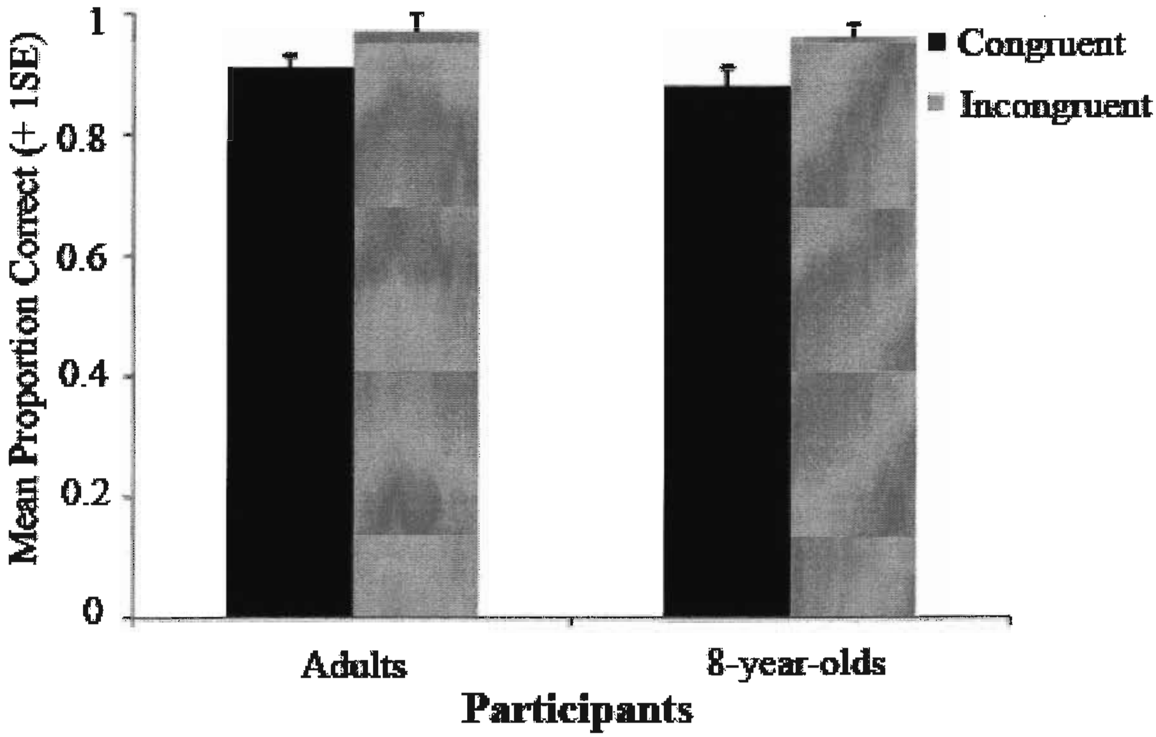

Figure 8. Adults' and 8-year-olds' mean proportion correct for aligned congruent and incongruent trials in Experiment 2. In all trials, the participants were asked to ignore the body and indicate whether the facial expression was displaying a happy or sad expression.

Discussion

In Experiment 2, unlike in Experiment 1a, both adults and children did not show an effect of context; the emotional body postures did not impair the participant's accuracy and speed of recognition of happy and sad facial expressions. As explained in detail in the general discussion, the differing results for Experiments 1a and 2 were predicted based on knowledge of children's sensitivity to facial expressions and both the Dimensional theory and the Emotional Seed model of emotion perception.

Furthermore, alignment did not affect the influence context on the recognition of happy and sad facial expressions. Although the lack of an alignment effect was predicted as a result of the lack of congruency effect, our results suggest that when emotions are very different from each other (in valence and arousal and physical characteristics) emotional information in the face and bodies may not be processed holistically.

General Discussion

Many participants included in the analyses reported in Experiments 1a, 1b, and 2 did not meet the inclusion criteria. Some of the participants failed visual screening, some failed trainings and some failed catch trials. The inclusion of participants who did not meet the criteria warrants the use of discretion when interpreting the results of these experiments. As a result of these errors and the lack of attention to procedures the conclusions made from the current set of data may not accurately reflect the influence of context on participants' perception of facial expressions. Instead, the reported findings may reflect participants' inability to perceive the details of the fearful facial expressions because of lack of normal vision, inadequate training with the stimuli, task difficulty and/or participants allocating attention to the body expressions instead of the facial expressions. See the Appendix 1 for details of the nature and magnitude of the errors and the implications of these errors for the findings reported in this thesis.

The primary goal of the current set of studies was to investigate the influence of emotional context on the perception of target facial expressions. Specifically, we were the first to investigate the influence of context on children's perception of facial expressions compared to that of adults. Both adults and 8-year-olds completed congruent (e.g., sad face with a sad body) and incongruent (e.g., fear face on a sad body) trials and were asked to determine which of two emotions the face was displaying; accuracy and reaction times were measured. A congruency effect (i.e., better performance on congruent than incongruent trials) reflected the influence of the emotional body postures on the participants' perception of the facial expressions. To investigate the conditions in which congruency effects occur, we tested both age groups with emotion pairs that varied in similarity. Like adults, 8-year-olds' recognition accuracy and response times were influenced by emotional body postures when the emotion in the face and body were similar (fear and sad, Experiment 1a) but not when the emotions were dissimilar (happy and sad, Experiment 2). Interestingly, when the emotions in the face and body were similar to each other (Experiment 1a), the magnitude of the congruency effect was larger for 8-year-olds than adults. This suggests that when the emotions displayed by the face and body are similar, 8-year-olds' perception of facial expressions is more influenced by emotional body postures than adults' perceptions. The secondary goal of the current set of studies was to directly examine one possible perceptual mechanism underlying both 8-year-olds' and adults' congruency effects—holistic processing. To test this, we used a modified version of the composite face paradigm. When the emotions were similar

(Experiment 1a) there was weak evidence of holistic processing. As predicted, when the emotions were dissimilar (Experiment 2) adults and 8-year-olds did not benefit from misalignment on incongruent trials.

Collectively, these results address three important questions: a) Why does similarity of emotional expressions influence the magnitude of congruency effects; b) Why do children have larger congruency effects than adults for similar emotions; c) Do adults and children process facial expressions and emotional body postures holistically?

Why does Similarity of Emotional Expressions Influence Magnitude of Context Effects?

A dominant theory of emotion perception in the literature is the Discrete Category theory. Proponents of this theory argue that discrete emotional categories (e.g., the basic expressions) are read directly from the facial expression (Ekman, 1970; Ekman & Friesen, 1982). In contrast to the dominant theory of emotion perception, the Dimensional theory and the Emotional Seed model argue that the recognition of facial expressions involves two stages. First the underlying valence, level of arousal (Dimensional theory) and quasi-physical characteristics (Dimensional theory and Emotional Seed model) are directly perceived and subsequently categorized as a specific emotional expression (Aviezer et al., 2008; Carroll & Russell, 1996; Russell, 1980;Schlosberg, 1952;Widen & Russell, 2008b). Both the Dimensional theory and Emotional Seed model provide a framework for understanding why the emotional information in the context influences the perception of facial expressions.

Density of emotions in the circumplex. According to the Dimensional theory, fearful expressions are negatively valenced and have high arousal; this combination of values on the underlying dimensions is also common to two of the other six basic expressions—anger and disgust. Thus, fearful expressions, unlike happy and sad expressions, reside in a high-density region of the circumplex. For each of the expression categories in this high-density region, the information provided by the facial expressions themselves may not be enough to allow the perceiver to accurately recognize the expression (Aviezer et al., 2008a). The influence of context on the perception of emotions that are located in the high-density versus the low-density regions of the circumplex have not been examined previously; all of the studies examining the influence of context on the perception of facial expressions have used at least one expression that is located in the high-density region of the circumplex (e.g., Aveizer et al., 2008a; Meeren et al., 2008; Righart et al., 2006; Righart & de Gelder, 2008; Van den Stock et al., 2007). Presumably, in each of these studies, the context was perceived by the participants (along with the facial expression) and used as a cue to the recognition of the facial expressions.

As predicted by the Dimensional theory, in the current set of studies congruency effects were found in Experiment 1a, in which one of the expressions (fear) is located in a high-density region of the circumplex. However, congruency effects were not found when the emotions displayed by the face and body were located in low-density regions of the circumplex (Experiment 2). Thus one interpretation of these results is that when the target facial expression is easily confused with other expressions because it is located in a high-density region of the circumplex, the perceiver uses the emotional information in the context to categorize the facial expression. This influence of context occurs regardless of whether the context was congruent (this facilitates performance) or incongruent (this leads to misidentification and the presence of a congruency effect). In everyday social interactions the information observed in the face and body are usually congruent, thus it is typically adaptive for perceivers to use the information in the context to aid the perception of ambiguous facial expressions.

Similarity in valence and arousal conveyed by the face and body. According to the Dimensional theory, congruency effects should occur when the emotions observed in the face and body are similar on one or more emotional dimensions (valence and/or arousal). When the emotion conveyed by the context shares arousal levels and/or valence with the emotion conveyed by the face the context may alter the observer's perception of the facial expression. For example, imagine a person displaying a fearful facial expression, but the body posture is displaying sadness and the background scene is a funeral. If you were shown this image briefly and asked to recognize the facial expression it would be easy to incorrectly say that the person was displaying a sad face. This is less likely to happen if the emotion conveyed by the context does not have the same valence and/or level of arousal as the emotion conveyed by the face. For example, imagine a person displaying a fearful facial expression, but the body posture is displaying happiness and the background scene is a birthday party. If you were shown this image briefly you would be unlikely to confuse the fearful facial expression for a happy facial expression.

Previous studies are consistent with this interpretation and reveal congruency effects for adults when the facial expressions and emotion conveyed by the context are similar on levels of either both dimensions (e.g., Meeren et al., 2005) or at least one of the underlying dimensions (e.g.,Van den Stock. et al); the magnitude of the congruency effects were larger for the pairing that was similar on both valence and arousal compared to the pairing that was only similar on arousal levels. Thus, these studies provide evidence that similarity on at least one underlying dimension produces congruency effects for adults.

To strengthen the argument that the similarity of emotions conveyed by the face and body, in terms of the underlying dimensions, modulates the magnitude of the congruency effect in the current study we examined the influence of context for sets of emotions that were similar on either one or neither dimensions (Experiment 2). Congruency effects were found for fearful and sad expressions (both negatively valenced, yet differ in arousal) and not for happy (positive valence and high arousal) and sad (negative valence, low arousal) expressions. The results of our study are the first to directly provide evidence that congruency effects only occur when the facial expression and context expression are similar on at least one of the underlying dimension.

Physical similarity in facial displays of emotion conveyed by the face and body. A final possible explanation of why congruency effects occurred for fearful and sad expressions in Experiment 1a and not for happy and sad expressions in Experiment 2 is that congruency effects only occur when the expressions conveyed by the face and context share physical similarities. According to the both the Dimensional theory and the Emotional Seed model all of the basic expressions vary in how physically similar they are to each other. For example, the expressions of both anger and disgust both involve furrowed brows. The proponents of the Emotional Seed model describe this similarity by suggesting that these expressions share 'emotional seeds'. The patterns of physical similarity between the expressions are reflected in Figure 2 (see Susskind et al., 2007). Unlike proponents of the Dimensional Theory, proponents of the Emotional Seed model emphasize that when facial expressions are presented in isolation, the physical similarity between facial expressions is not relevant (i.e., the seeds for alternative emotions are dormant). However, when the facial expression is observed within a context depicting another expression, the recognition of the facial expression will be influenced by the context expression if the emotion displayed in the face shares physical similarities with facial displays of the emotion displayed in the context (i.e., the emotional seeds will grow).

Recently, Aviezer et al. (2008b) provided evidence that the more physically similar the facial expressions are, the larger the influence of context is. In this study, adults were shown facial expressions of disgust paired with emotional contexts (i.e., body and props) conveying expressions associated with facial expressions that varied in physical similarity to disgust. In the congruent condition, disgust facial expressions were observed within the context of disgust. In the incongruent conditions, facial disgust was paired with angry, sad and fearful contexts with angry being the most and fearful being the least physically similar to disgust. Congruency effects were found for all of the incongruent pairs with the largest effects shown for disgust and angry, intermediate effects for disgust and sad, and the smallest effects found for disgust and fearful expressions. The results of study by Aviezer et al. (2008b) provide evidence that the physical similarity of the expressions conveyed by the face and context modulate the influence of the context of the recognition of facial expressions.

The results of the current set of studies can be interpreted by the Emotional Seed model and are consistent with the results found by Aviezer et al. (2008b). In Experiment 1a, congruency effects were found for fearful and sad expressions. Fearful and sad expressions share physical similarities as demonstrated by their close proximity to each in

Figure 2 (reflecting judgments made on the physical appearance of expressions by a computer model and by humans). Therefore, the congruency effect found in Experiment 1a may have occurred because of the physical similarity between the expressions conveyed by the face and the facial expressions associated with emotion conveyed by the context. In contrast, in Experiment 2, congruency effects were not found for happy and sad expressions. This finding is consistent with the Emotional Seed model as happy and sad facial expressions do not share similar physical characteristics and are located opposite each other in the Figure 2. Thus, in accordance with the Emotional Seed model and as evidenced by Aviezer et al. (2008b) and the current study, when the emotions conveyed by the face and context share physical similarities the context can influence the recognition of facial expressions.

In sum, there are three possible explanations for the results in the current set of studies: a) the density of the area in which the target facial expression is located on the circumplex, b) the similarity in valence and arousal of the emotion conveyed by the face and body, and c) the physical similarities between the facial expression and the facial expression associated with the emotion displayed by the body. Of course, our results do not allow us to examine the relative contribution of each of these explanations. After all, not only do happy and sad each reside in a very low-density area of the circumplex, but they also differ on both valence and arousal and have different physical characteristics.

Future research is required to examine the relative contributions of these three aspects of similarity on the magnitude of congruency effects. For example, a study that directly compares the magnitude of congruency effects for pairs of emotions that are similar as defined by the Dimensional theory (based on density and similarity in valence and arousal), to pairs of emotions that are similar as defined by the Emotional Seed model (based on physical characteristics) needs to be implemented. The Dimensional theory predicts that the pairing of angry and fearful expressions would produce a larger congruency effect than the pairing of angry and sad expressions. According to this theory, angry and fearful expressions are likely to influence the perception of one another because they are each located in a high-density area of the circumplex and have similar valence and level of arousal (see Figure 1). The pairing of angry and sad expressions are likely to influence each other, but the magnitude of the congruency effect should be smaller than that of angry and fearful expressions; although anger is located in a high-density area of the circumplex, sad is not. In addition, these expressions are only similar on valence, not arousal. In contrast, the Emotional Seed model predicts that angry and sad expressions would produce a larger congruency effect than the pairing of angry and fearful expressions. According to this model, angry and sad expressions are likely to influence the perception of one another because they are physically similar to each other; angry and sad expressions are located only one step away from each other on models representing physical similarities between facial expressions (see Figure 2). On the other hand, angry and fearful expressions are likely to influence each other, but the magnitude of the congruency effect should be smaller than that of angry and sad expressions; angry and fearful expressions are located two steps away from each other (see Figure 2).

In sum, our studies and previous research provide evidence that collectively the density of where the target expression is located in the circumplex, the similarity between valence and arousal of the face and physical similarity of the expressions conveyed by the face and body influence the magnitude of congruency effects. Future research will provide insight into relative contributions of each of the aforementioned explanations.

Why do children have larger congruency effects for similar emotions than adults?

The magnitude of the congruency effect for 8-year-olds was significantly larger than that of adults when the expressions in the face and body were similar in valence and arousal (Experiment 1a). Two possible explanations are examined.

The allocation of children's attention. One possible explanation of the larger congruency effect for 8-year-olds compared to adults in Experiment 1a is that the 8-year-olds were unable to allocate attention to the face and ignore the information in the body even though they were instructed to do so. The ability to attend to target stimuli and ignore irrelevant stimuli begins during infancy and develops gradually throughout childhood (Wellmen, 1988). However, it is well established that on visual and auditory attention tasks, children of approximately 8-10 years of age have the ability to successfully attend to relevant information and ignore irrelevant information at an adult-like level, with few improvements after this age (Klenberg, Korkman, Lahti-Nuuttila, 2001; Rebok et al., 1997). Thus, in the current set of studies, the task of ignoring the body and indicating which of two expressions was displayed by the face was age appropriate and it is unlikely that the children were only attending to the body postures throughout the task. In addition, all of the experiments in the current study included a task that directly measured attention; all participants completed catch trials in which they were required to recognize a novel facial expression that was presented within the context of an emotional body posture (fear and sad). Children, like adults, were able to consistently identify the novel facial expression on the catch trials. Thus, this measure of attention provides evidence that all participants were able to allocate attention to the facial expression to accurately recognize the facial expression.

However, despite having direct evidence that children attended to the emotional faces, it is possible that the 8-year-olds did attend to the body more than the adults throughout the experiment. Thus a possible explanation is that although both adults and children attended to the facial expression, the children may have looked first or more often towards the body than adults. To directly measure if the children were attending to the body more than the face future studies should record and compare the fixation patterns of adults and 8-year-olds. This would allow us to quantify and compare the attention each age group paid to the face compared to the body.

The development of children's emotion categories. The most plausible explanation for the larger congruency effect for 8-year-olds compared to adults in Experiment 1a is that 8-year-olds' emotional categories for fear and sad are not yet adult-like. The result of Experiment 1b indicates that children's low accuracy on the task per se is not related to the magnitude of the congruency effect. Nonetheless, because children are immature at discriminating fear and sad they may rely on body posture (i.e., on contextual cues) more than adults.

As previously mentioned the development of adult-like sensitivity to the basic facial expressions is gradual. Although children's circumplex may be structurally similar to that of adults at age five (Russell & Bullock, 1985), even at age 14 the underlying neural mechanisms (as measured by event-related potentials) for the basic expressions are still not adult-like (Batty & Taylor, 2006). Furthermore, the systematic way in which children's perception and understanding of emotion develops suggests that discriminating two negatively-valenced emotions, such as fear and sad, may require that children adopt a different strategy than discriminating two emotions that are oppositely valenced. Children first acquire the label and have adult-like recognition for happy, the only positively-valenced basic expression. Thus, valence appears to be the first dimension to which children are sensitive which means that when children are discriminating happy expressions from any other emotion they may simply be judging positive versus negative valence rather than discriminating two specific facial expressions. In contrast when discriminating two negative emotions (which do not differ on valence) children must attend to either arousal or to specific emotions. Subsequently, throughout elementary school children begin to acquire labels for the negative expressions in a specific order (i.e., sad, angry, fearful, surprise and disgust, with the order for sad and angry sometimes reversed). Dimensional theorists argue that children begin to differentiate between the negative expressions by using the underlying dimension of arousal (Widen & Russell, 2003; 2008a), and so first discriminate sad (low arousal) from other negative emotions. The basic emotions that are located in the high-density area of the circumplex all share negative valence and high levels of arousal and as a results are the last emotional categories to be refined (i.e., angry, fear and disgust). Prior to acquiring these additional labels, the earlier acquired labels (e.g., sad, angry) are applied to more than one expression. Thus, throughout elementary school children misidentify the later-developing expressions more often than earlier developing expressions.

Multiple studies suggest that children consistently confuse fear with sadness. For example, Gao & Maurer (2009) showed children and adults faces displaying happy, sad, and fearful expressions at various levels of intensity. They measured participants' sensitivity to these expressions in two ways. First, they measured sensitivity thresholds, defined as the intensity of the facial expression required to distinguish each of the expressions from neutral. For happy and sad expressions, even 5-year-olds had adult-like sensitivity thresholds. In contrast, for fearful expressions, both 7-year-olds and 5-year-olds had higher thresholds than adults. Second, they measured the frequency with which children mislabeled each of the expressions. For happy expressions, every group of children had adult-like accuracy, even at low intensities. For sad expressions, even 5-year-olds had adult-like accuracy for the most intense expressions, but even 10-year-olds made more errors than adults when expressions were less intense (20% to 70%). When children did make errors they mistook sad faces for fearful faces. For fearful expressions, only 5-year-olds made more errors than adults across all levels of intensity. When 5-year-olds made errors they mistook fearful faces for sad faces. Congruent with the Gao & Maurer's results, other studies provide evidence that children do not have adult-like recognition of fearful facial expressions until 10-12 years of age (Camras & Allison, 1985; Markham & Wang, 1996; Vicari et al., 2000). In most previous studies (but see Durand et al., 2007) children were given unlimited viewing time; in the current study stimuli were presented for only 600 ms, increasing task difficulty. Thus, although we trained the 8-year-olds in the current study to 80% accuracy for the facial stimuli, at this age they are still immature at recognizing the expressions used in this study (especially fear) and perhaps as a result, were more influenced by the emotions in the context than adults. In sum, a review of the current Dimensional theory literature suggests that the gradual and systematic development of children's emotional categories is another salient explanation for our results.

Future studies are required to provide further evidence for this explanation. For example, if the magnitude of children's congruency effects is predicted by the development of their emotional categories then future studies should investigate the influence of emotional body postures on 5-year-olds' perception of happy and sad facial expressions. As previously reviewed, by 5 years of age children have adult-like emotional categories for happy facial expressions and, based on valence, they discriminate happy from all negatively valenced emotions (Widen & Russell, 2003). Thus, even at this age, children may not show a congruency effect when the emotions in the face and body are different in valence. However, children at this age may perform well on this task because they performed a simple happy/non-happy task instead of distinguishing between happy and sad.

In addition, a future study could examine older children's congruency effects for fearful and sad expressions. By 10-12 years of age children have adult-like recognition of fearful and sad expressions and their sensitivity to both valence and arousal is better developed than at younger ages. If the refinement of the emotional categories predicts the magnitude of the influence of context on the perception of facial expressions then 10-12 year-olds should have congruency effects that are similar in magnitude to those of adults. Examining the influence of emotional contexts on the perception of facial expressions at various ages throughout childhood will help us better understand the development of children's sensitivity to emotional expressions.

Does Holistic Processing Contribute to the Influence of Context?

Although there is evidence that emotional contexts influence the perception of facial expressions, little research has been done to examine the perceptual processes involved in congruency effects. One perceptual process that may underlie congruency effects is holistic processing. Holistic processing occurs when a stimulus that is made up of various features is perceived as a whole, or gestalt, and the features are not directly perceived. It is well established that individual faces are processed holistically (Tanaka & Farah, 1993) and we hypothesized that facial expressions and emotional body postures may be processed holistically as well. For example, the face and body would be perceived as one stimulus (i.e., a person) as opposed to separate parts (i.e., a face and a body). Holistic processing of the face and body would make it difficult for the perceiver to separate the emotion conveyed by the face from the emotion conveyed by the body and increase the likelihood that the perceiver would misidentify the facial expression as the emotion conveyed by the body. A modified version of the classic measure of holistic processing, the composite face task, was used to test for holistic processing; the composite face task predicts that the misalignment of two sources of information (i.e., the face and the body) should disrupt holistic processing and increase performance when the two parts of the gestalt are incongruent. In the current set of studies, we did not find robust evidence for holistic processing of briefly presented facial expressions within emotional contexts. When the emotions were similar (Experiment 1) there was weak evidence of holistic processing; only the 8-year-olds benefited from misalignment in Experiment 1a (although the analysis of residual suggests that participants' variability on congruent trials drives the age difference) and adults benefited from misalignment in Experiment 1b. As predicted, when the emotions were dissimilar (Experiment 2) adults and 8-year-olds did not benefit from misalignment on incongruent trials.

A possible explanation of the current results is that facial expressions and emotional contexts were not processed holistically. Instead the emotional information from the two sources may be processed rapidly, automatically and simultaneously, but not typically as an integrated whole. The current study is the first to *directly* test for holistic processing and our weak evidence for holistic processing is inconsistent with interpretations of the mechanism driving congruency effects in two other studies. First, Meeren et al. (2005) found congruency effects in both a behavioural study and an electrophysiological study. When adults were presented with congruent and incongruent face and body emotions, the emotional body postures influenced adults' recognition of rapidly presented (200ms) facial expressions. The results from the ERP study found a marker of early perceptual processing (P1) at 115 ms, with a larger peak for incongruent stimuli. Meeren et al. provide evidence that emotions in the face and body are processed rapidly and speculate that the larger peak for incongruent stimuli indicates that the facial expressions and emotional body postures were processed holistically. Thus, although the researchers hypothesized that holistic processing contribute to the congruency effects, without directly testing for holistic processing it is unclear whether the information in the face and body was simply processed simultaneously or as an integrated whole (i.e., as a gestalt). Results from the current study suggest cautious interpretation of indirect tests of holistic processing.

In addition, a recent study by Barrett & Kensinger (2010) provides further evidence that context is implicitly and rapidly encoded during forced-choice facial expression recognition tasks. Adults were shown pictures of emotional facial expressions (e.g., fear and disgust), neutral faces or objects, each presented separately on neutral backgrounds (e.g., a grocery store). Participants were either asked to recognize the facial expressions or to decide if they would approach or avoid the target person (a behavioural/action task). Memory for information in the background scene was measured following both tasks. Adults had better memory for contextual scenes following a facial expression recognition task than the approach-avoid task. Furthermore, the facilitation of memory for context was present only when judging facial expressions (i.e., was absent when tested with neutral faces or objects). Thus, Barrett and Kensinger provide evidence that when participants are asked to recognize facial expressions within a context, the stimuli are processed differently than when the participants were asked to make a behavioural decision or when the target stimulus was an object or a neutral facial expression. One possible explanation of Barrett & Kensinger's results is that when participants recognize facial expressions within context they process the stimuli holistically. On the other hand, congruent with our results, without a direct test of holistic processing it is difficult to know if the better memory for the context during facial expression recognition tasks was a result of rapid, simultaneous processing or holistic processing. Again, cautious interpretation is suggested.

Our results and that of one previous study suggest that rather than processing faces and bodies holistically, adults (and children) may first process the face and body as independent parts and that the clarity of information in each part and the degree of similarity between the emotions conveyed by each part determines the extent to which the observer's perception of the facial expression interacts with their perception of context. Aviezer et al. (2008b) provided evidence that body postures maximally influence adults' perception of facial expressions when the emotions displayed by the face and body are similar, and that attentional mechanisms underlie this effect (i.e., face scanning patterns are altered by incongruent body postures, at least when the emotions conveyed by these two sources are similar). Thus, this study provides evidence that visual attention bias (an early perceptual process) is influenced by the emotional context. Likewise in the current set of studies, emotional body posture influenced adults' and children's perception of facial expressions when the two emotions were similar (sad and fear) but not when the two emotions were dissimilar (sad and happy). These results suggest that, unlike faces (Tanaka & Farah, 1993), the parts (face, body) may be processed before the whole when adults and children view whole face-body images.

This raises a final question: If we argue that the participants did not process the facial expressions and body postures holistically, then why did children (Experiment 1a) and adults (Experiment 1b) benefit from misalignment if they did not process the images holistically? We propose that the misalignment of the face and body increased the distance between the target (face) and distracter (body) and thus may have allowed the participants to ignore the body more easily and focus on the face, thereby improving their performance on misaligned trials. To further investigate this possibility, a task that effectively disrupts holistic processing, without increasing the physical distance between the face and body (i.e., without making it easier for participants to ignore the body) is required. For example, instead of misaligning the face and body, the face could be placed in the center of the body. This task would prevent the participants from processing the face and body holistically without increasing the physical distance between them. If participants' performance on incongruent trials increased on the trials in which the face was in the center of the body compared to aligned trials then this would provide evidence that participants were processing the information in the face and body holistically.

Alternatively, if the participants' performance on incongruent trials in which the face was in the center of the body did not increase compared to aligned trials this would provide evidence that the participants had benefitted from misalignment because they were unable to ignore the body. The results from this study would provide further insight into the interpretations of the current set of experiments and the three previously reviewed studies.

Summary

We were the first to examine if children's perception of facial expressions was influenced the emotional context. Like adults, 8-year-olds were influenced by the emotion in the context and this effect reflected the similarity between the emotions conveyed by the facial expressions and context. The influence of context was greater for 8-year than adults for similar expressions (fear and sad), perhaps because of the prolonged development of emotion perception and understanding. This pattern of results is consistent with both the Dimensional theory and the Emotional Seed model of emotion perception and with a growing body of work showing that human faces may have undeservedly captured the attention of researchers for decades, to the exclusion of other important cues to the emotional state of those around us. Our results pave the way for a new line of research in which the development of emotion perception during childhood is studied with increased ecological validity and children view faces in the context of bodies, background scenes, hand gestures, other faces and voices.

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Appendix 1

Errors with Visual Screening

Nature of Errors. All participants completed two visual screening tests; one to assess their acuity and another to assess their depth perception. In order to pass the screening and be included in the study participants were required to meet specific criterion associated with each screening measure. For the acuity assessment, children and adults were to accurately identify the letters on the acuity chart to a 20/20 vision level. Participants were allowed two errors per eye. If participants made more than two errors per eye they were asked to attempt to identify letters below the 20/20 vision line. If the participants could accurately identify letters at an acuity level higher than 20/20, then for every correct response one incorrect score was to be subtracted from their total number of errors. For the depth perception assessment, children and adults were to complete three short tasks assessing fine and gross depth perception. Participants who successfully completed the tasks without error were to be included in the final analyses and all others were to be excluded. However, a further examination of the visual screen data found that participants who did not meet the previously mentioned visual screening criterion were tested and included in the data sets in each of three experiments. Thus, the results and conclusions of this thesis are to be interpreted with caution.

Magnitude of Errors. In Experiment 1, four out of the 16 adults (25%) and nine out of the 16 children (56%) failed to meet the visual screening criteria, yet were included in the analyses. In Experiment 1b, adults in each of the four conditions failed visual screening and were included in the analysis: In the 100% condition 1 adult (6%) failed visual screening, in the 70% condition four adults (25%) failed visual screening, in the

40% condition 5 adults (31%) failed visual screening and in the 20% condition 2 adults (13%) failed visual screening yet were included in the analysis. In Experiment 2, six children (38%) and four adults (25%) failed visual screening and were included in the final analysis. Overall, 35 out of 128 (27%) participants did not meet the inclusion criteria for visual screening and were included in the final analyses in this thesis. In the experiments that included both children and adults (Experiments 1a and 2), there were more children who failed visual screening and were included in the final data set than adults.

Implications of Errors. The visual screening measures were used in this study to ensure that both children and adult participants had normal vision. Normal vision was required because the experiment involved attention to complex visual stimuli (i.e., the face, the body, and face-body images) presented on a computer screen located 60 cm away. The use of the acuity test is important for this study because children and adults reply on high spatial frequencies when perceiving facial expressions. Thus, if participants did not have normal or corrected to normal vision then they may have been unable to perceive the muscle activations associated with the specific facial expressions that were displayed on the screen. Thus, the context effects found for both children and adults may reflect their inability to identify or discriminate between the facial expressions and not an influence of context on participants' perceptions. Specifically, the conclusions of this thesis are that children are more influenced by the context than adults, but only for the pairing of sad and fearful emotions. Perhaps the results can be explained by the fact that more children who failed visual screening were included in the final analysis than adults who failed visual screening. In order to compare the influence of context on children's and adults' perceptions of facial expressions all participants must have the same level of visual acuity and depth perception in order to ensure all participants can perceive the details of each facial expression. Thus, the data reported in this thesis cannot conclusively support the interpretations provided in the results and discussion sections of this thesis.

Errors with Training Criteria

Nature of the Errors. In each of the three experiments participants completed a set of training trials prior to the test trials to ensure that they understood the instructions and could accurately identify the isolated facial expressions. All participants completed four practice trials (two sad faces and two fearful faces) in which faces were presented for two seconds and then eight trials in which the isolated faces were presented for 600 ms. To meet the training criteria participants were to correctly identify six of the eight training stimuli before continuing with the experiment; each of the participants were supposed to be allowed three attempts to meet the inclusion criteria. If participants did not meet this criterion they were to be excluded from the final analyses. Upon further inspection of the training data, three types of errors were found. First, training data was not recorded for many of the participants and so accurate performance during training cannot be validated. The lack of records is problematic because data from an additional group of children who were tested on this task but not included in the thesis (10-year-old children tested on sad/fear) indicate that several participants in that group failed training on their first attempt, were not given additional attempts, but were included in the analysis.

Magnitude of the Errors. No training records were kept for the participants in Experiments 1a and 1b. In Experiment 2, training records were not kept for one of the child participants. The specific score was not recorded.

Implications of the Errors. Without consistent and specific records of the participants' training scores we cannot conclude that the children and adults understood the procedures and that the task was appropriate for the age group of children tested. Specifically, without assurance that the participants could pass the training criterion trials we cannot conclude that results of the three experiments reflect a perceptual phenomenon related to the perception of faces in the context of bodies. Instead, the results could indicate that some of the participants may have not understood the procedures or may have been unable to accurately identify the facial expressions displayed by the models in the study. In addition, in the current set of studies we cannot conclude that the task of ignoring the body and indicating which of two expressions was displayed by the face was age appropriate for the 8-year-olds in the study. Thus, without specific training records for participants we cannot dismiss the possibility of a floor effect. In Experiment 1a, many of the children scored below chance (.50), thus their performance was so poor that it could not be influenced by the context. Specifically, if the children did not understand the task or could not identify the facial expressions then the context effect found may reflect that the children's performance became random and/or that they relied on the body. If the training scores were carefully kept and monitored then task difficulty could be controlled for.

Errors with Catch Trials

Nature of the Errors. In each of the three experiments participants completed catch trials. The catch trials consisted of stimuli displaying facial expressions that were not tested during the experiment (e.g., in Experiments 1a and 1b the models in catch trials stimuli displayed happy facial expressions). These trials were included to provide a measure of the participants' attention to the facial expressions and proper completion of the task. To be included in the final set of analyses the participants were to correctly identify at least 81% of the catch trials in each of the conditions listed above. In Experiments 1a and 2, children in each of these studies did not meet the catch trial criterion, yet were included in the final analyses of the studies.

Magnitude of the Errors. In Experiment 1a, two children did not pass the catch trials; one of the children responded correctly on nine of the 16 catch trials (56%) and another child responded correctly on 12 of the 16 catch trials (75%). In Experiment 2, two children also failed to pass the catch trials; both children responded correctly on 10 of the 16 catch trials (62%).

Implications of the Errors. As a result of including participants who did not pass the catch trials criterion it is possible that those children were only attending to the body postures throughout the task. Thus, this measure of attention cannot conclusively provide evidence that all participants were able to allocate attention to the facial expression to accurately recognize the facial expression. Specifically, the children who did not pass the catch trials may have had higher scores on congruent trials than incongruent trials because they were paying attention to the body and not because of a context effect. These scores may have falsely enhanced the congruency effect found for the participants who did pass the catch trials and thus made it appear as though children's context effect was larger than that of adults.